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AIR BRAKE TEXT

FOR

ENGINEERS
and FIREMEN

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A COMPLETE TREATISE ON THE WESTING-
HOUSE *and* NEW YORK AIR BRAKE
and SIGNAL SYSTEMS
AIR BRAKE PRACTICE
and
TRAIN HANDLING

PREPARED EXPRESSLY FOR THE
NATIONAL CORRESPONDENCE SCHOOL
OF RAILROADING
CHICAGO

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P R E F A C E

THE Air Brake Text for Engineers and Firemen was prepared expressly for the **National Correspondence School of Railroading**, by locomotive engineers who have had years of experience in practical air brake practice. ¶ Each subject is thoroughly and briefly treated in plain, comprehensive language, and can be easily understood by all who give the text careful study. ¶ The subjects contained herein are not elaborated on, but are briefly explained and cover all the points necessary to qualify the engineman to pass a thorough examination on air brake operation. ¶ It is unlike all other air brake text-books and catechisms which contain a large amount of matter pertaining to brake leverage, mathematical problems, calculations of braking power, and maintenance of equipment in repair yards, which have been omitted in this text, with a view of qualifying the engineman to become competent in air brake practice. ¶ A knowledge of brake leverage, braking power and maintenance of air brake equipment is valuable to an engineman, but should not be confounded with practical air brake practice and train handling.

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THE WESTINGHOUSE AIR BRAKE

and

SIGNAL SYSTEM.

Plate 1 shows the general arrangement of piping upon a locomotive and tender. Plate 2 shows a sectional view of the essential parts of the air brake system and their relative location, as follows:

FIRST.—The steam driven air pump, which supplies the compressed air.

SECOND.—The main reservoir, in which the compressed air is stored.

THIRD.—The engineer's brake valve, which regulates the flow of air from the main reservoir into the brake pipe for charging and releasing the brakes, and also from the brake pipe to the atmosphere for applying the brakes.

FOURTH.—The air gauge, which is of the duplex pattern and shows simultaneously the pressure in the main reservoir and that in the brake pipe.

FIFTH.—The pump governor, which regulates the supply of steam to the pump, stopping it when maximum pressure has been attained.

SIXTH.—The brake pipe, which connects the engineer's brake valve with the main reservoir, and also with each triple valve in the train, including the flexible hose and the couplings between the cars.

SEVENTH.—The auxiliary reservoir, which is supplied with air from the main reservoir, through the brake pipe and triple valve.

EIGHTH.—The brake cylinder and piston rod, which are connected to the brake levers in such a manner that when the piston is forced outward by the air pressure the brakes are applied.

NINTH.—The quick action triple valve, which is connected to the brake pipe, auxiliary reservoir, brake cylinder and pressure retaining valve. It operates in accordance with the variations of pressure in the brake pipe: (1) to admit air from the auxiliary reservoir and the brake pipe to the brake cylinder, thereby applying the brakes, and at the same time to cut off communication from the brake pipe to the auxiliary reservoir; (2) to restore communication between the brake pipe and the auxiliary reservoir, and at the same time to discharge the air from the brake cylinder to the atmosphere, thereby releasing the brakes.

TENTH.—The hose couplings, which are attached to flexible hose, and serve to unite the brake pipes of adjoining cars.

ELEVENTH.—The pressure retaining valve, which, when used, prevents the complete discharge of the air from the brake cylinder, retaining a given pressure in the brake cylinder when the brakes are released.

TWELFTH.—The automatic slack adjuster, which automatically maintains a uniform travel of the piston in the cylinder by taking up the slack as the brake shoes wear away.

WESTINGHOUSE AIR PUMPS.

THE EIGHT-INCH AIR PUMP.

Operative Parts. Plate 3 shows the 8-inch air pump in its upward stroke. The principal operative parts of the valve gear are, the Steam Piston and Rod 10, the Air Piston 11, Piston Valves 7, Piston 23, Reversing Slide Valve 16, Reversing Rod 17 and Reversing Plate 18. Valves 30 and 30 are the Air Discharge Valves, and 31 and 31 the Receiving Air Valves.

Operation—Steam End. The steam enters chamber *m* and port *h*, uniting chambers *m* and *e*, and conducts the steam from the former to the latter, which contains the reversing valve.

When reversing slide valve 16 is in the position shown on Plate 3, steam passes from chamber *m*, through port *h*, into chamber *e*, and thence through port *a* into chamber *d*, above reversing piston 23. The same steam pressure now acts downward upon piston 23 and lower piston valve 7, and upward on upper piston valve 7, but as the combined areas of piston 23 and lower piston valve 7 are greater than of upper piston valve 7 the steam forces piston 23 and piston valves 7 downward to the position shown. Steam is admitted to the cylinder through the upper ports in bushing 26, raising piston 10, while the steam above piston 10 passes through the upper parts in bushing 25, thence through bushing *f, f*, shown by dotted lines, into chamber *g* and out at Y, through an exhaust pipe to the smoke arch, from which it is discharged to the atmosphere through the smoke-stack. When piston 10 has nearly completed its upward stroke, reversing plate 18 engages shoulder *n* and also raises reversing valve 16 to its uppermost position, in which port *a* is closed, and as the cavity in the valve connects ports *b* and *c*, the steam above piston 23 is discharged through port *b*, the cavity in reversing slide valve 16, port *c* and port *f, f*, into chamber *g*, and thence to the atmosphere through the exhaust pipe at Y.

When piston 10 has nearly completed its downward stroke,

the lower face of reversing plate 18 engages the button at the lower end of the reversing rod 17, drawing the reversing slide valve down, and the motion of the pump is again reversed.

Operation—Air End. During the upward stroke of the pump the air above piston 11 is compressed and discharged through port *p* into the space between receiving valve 31 and discharge valve 30, forcing the latter from its seat and flowing through chamber *t* and port *r*, into chamber *s* and out at *z* to the main reservoir.

The main reservoir pressure in chamber *s* holds lower discharge valve 30 upon its seat during the upward stroke of the pump, and, a partial vacuum being formed below piston 11, lower receiving valve 31 is forced from its seat by atmospheric pressure, which then enters the lower part of the air cylinder. In the downward stroke of the pump the conditions are reversed; upper receiving valve 31 is lifted to fill the chamber above piston 11 as it descends, and the air compressed below the piston forces valve 30 from its seat and flows through chamber *g* and the pipe connected at *z* to the main reservoir.

Valve Lifts. The receiving valve should have a lift of one-eighth of an inch and the discharge valves three thirty-seconds of an inch.

Purposes of Operative Parts—Steam End. The steam portion of the air pump is practically a small engine, containing a steam cylinder, a main piston and valve gear, so arranged as to admit and exhaust steam to and from opposite sides of the steam piston.

The purpose of the reversing valve piston 23 is to assist the smaller main valve piston 7 in overcoming the pressure of the large main piston 7, when moving the main valve to its lower position.

The reversing slide valve 16 admits and exhausts the steam to and from the top of reversing piston 23.

The reversing valve rod 17 raises and lowers reversing slide valve 16.

The main valve piston 7 admits and exhausts steam to and from the cylinder.

When the throttle is open, the steam pressure from the boiler is always constant upon the two inner faces of the main valve piston 7.

Exhaust and atmospheric pressure is always present upon the two outer ends of the main valve piston.

THE NINE AND ONE-HALF-INCH PUMP.

Construction. The 9½-inch pump is shown on Plates 4 and 5. The following description is applicable to either the right or the left-hand pump. The only difference between the two pumps is the location of the steam and exhaust connections, for convenience in piping.

The valve gear of the pump consists of pistons 77 and 79 of unequal diameter, connected by rod 76, which imparts the movement of the pistons to slide valve 83, and this valve in turn controls the steam supply which operates the main steam piston 59. The reversing of pistons 77 and 79 is controlled by the reversing slide valve 72 (Plate 5), the duty of which is to admit and discharge steam to and from chamber D, at the right of piston 77.

Chambers A and C are always in free communication through ports *e, e*. The reversing valve is operated by rod 71, to which movement is imparted by reversing plate 69, which engages reversing button *k* on the downward stroke of the steam piston, and shoulder *j* on the upward stroke.

Chamber E always communicates with the exhaust in order that no back pressure may occur when piston 79 is forced to the left, and that a partial vacuum may not occur when the piston is forced to the right. The exhaust is made by means of port *t*, shown in the main valve bushing. This port leads from chamber E directly to the main exhaust port *d*, so that chamber E, at the left of piston 79, is always free from steam pressure.

When the reversing slide valve 72 is in the position shown,

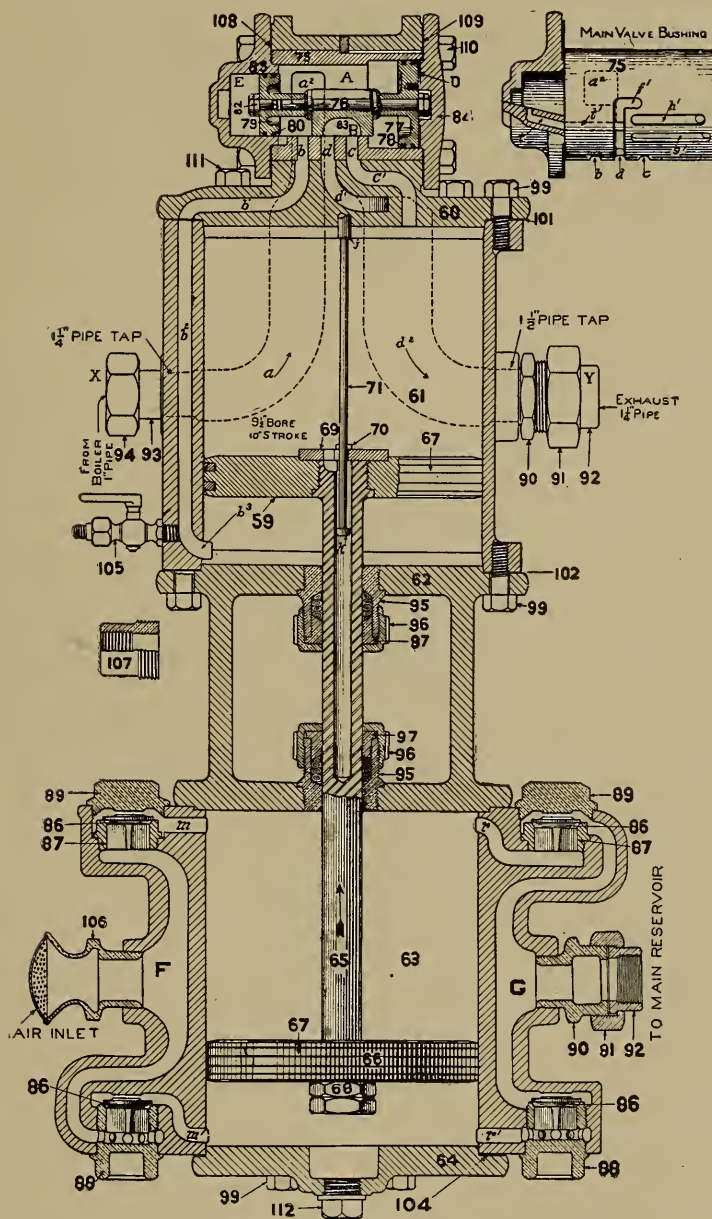


PLATE 4.

chamber D is connected through ports h, h , reversing valve cavity H and ports f, f , with the main exhaust passage d, d , and there is no pressure to the right of piston 77.

Operation—Steam End. As steam enters the pump at X it passes through passage a^1, a^2 , into chamber A, between pistons 77 and 79. The area of piston 77 being greater than that of piston 79, piston 77 is forced to the right, moving with it piston 79 and slide valve 83 to the position shown on Plate 3, thus admitting steam below piston 59, through port b, b^1, b^2 . Piston 59 is then forced upward and the steam above piston 59 passes through port c, c^1 , cavity B of slide valve 83, port d and passage d^1, d^2 , to connection at Y, at which point it is discharged from the pump to the atmosphere through the exhaust pipe.

When piston 59 reaches the upper end of its stroke, reversing plate 69 strikes shoulder j and rod 71, forcing it and the reversing slide valve 72 upward sufficiently to expose port g . Steam from chamber C then enters chamber D, through port g and port g^1 of the bushing (Plate 4). The pressures upon the two faces of piston 77 are thus equalized and the piston is balanced. The pressure in chamber A acting upon small piston 79 forces it to the left, moving with it piston 77 and slide valve 83.

With slide valve 83 in its extreme position at the left, steam from chamber A is admitted through port c^1, c , above piston 59, forcing it downward. At the same time the steam below the piston is discharged to the atmosphere through port b^3, b^2, b^1, b , chamber B of the slide valve, port d, d^1, d^2 , and the exhaust pipe connected at Y.

When piston 59 reaches the lower end of its stroke, reversing plate 69 engages reversing button k , moving it and the reversing slide valve downward to the position shown on Plate 5, and one double stroke or cycle of the steam end of the pump has been traced.

Operation—Air End. The movement of piston 59 is imparted to air piston 66 by means of the piston rod. As piston 66 is raised, the air above it is compressed and air from the at-

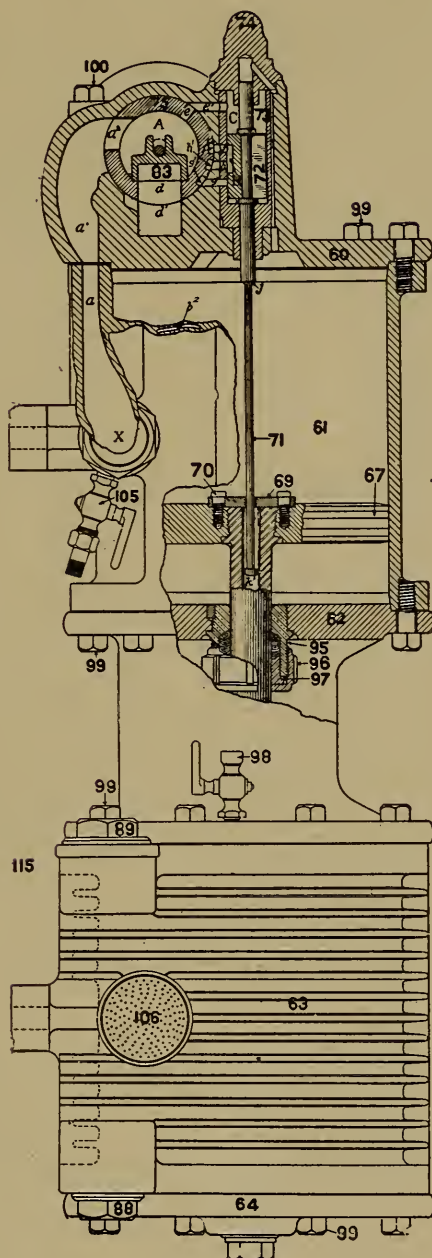


PLATE 5.

mosphere is drawn in beneath it, the conditions being reversed in the downward stroke.

As piston 66 is raised, the air above it is compressed and passes through port *r*, lifting discharge valve 86 from its seat. As the pressure below the valve is greater than the main reservoir pressure above it, the air passes down into chamber G, and thence into the main reservoir. The upward movement of the air piston produces a partial vacuum, which causes the lower left-hand receiving valve 86 to lift from its seat, and atmospheric pressure enters through the strainer at the air inlet and passes to chamber F, below the receiving valve, thence past the valve into port *m*, and into the lower end of the air cylinder, filling the cylinder. In the downward stroke of the pump the air passes the discharge valves to the main reservoir in the same manner as previously described.

The receiving and discharge valves of the 9½-inch pump should each have a lift of three thirty-seconds of an inch.

Diagrammatic Views. Plates 6 and 7 show diagrammatic views of the 9½-inch pump, with all ports leading to and from the pump exposed, so that they can be plainly seen and the operation of the pump easily understood. Plate 6 shows the pump on its upward stroke, and Plate 7 on its downward stroke.

Starting the Pump. When the pump is started it should be run very slowly, until it becomes warm and the condensed steam has worked out of the steam cylinders through the drain cocks and exhaust pipe, which will allow an air cushion to accumulate in the air cylinder.

The lubricator should be put in operation immediately after the pump has been started.

Lubrication—Steam and Air End. A swab well oiled should be kept on the piston rod. The amount of oil required in the steam cylinder of the pump depends largely upon the amount of work performed. Some pumps require more oil than others. Judgment should be used in determining the amount of oil required.

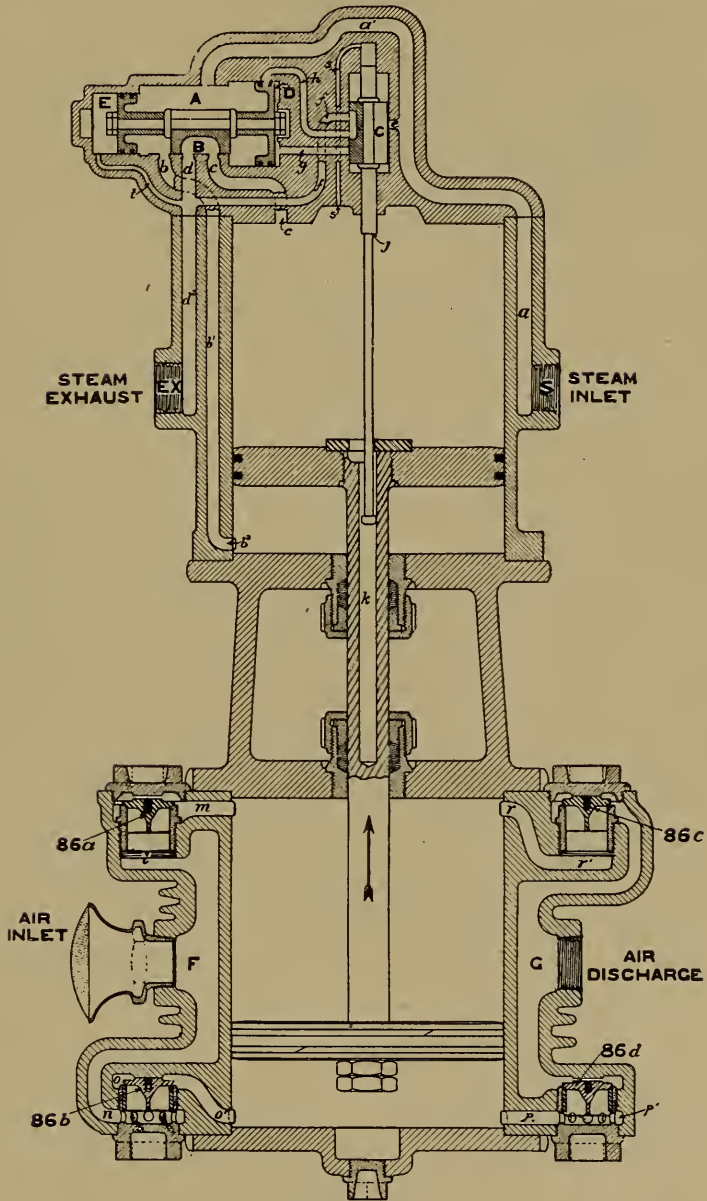


PLATE 6.

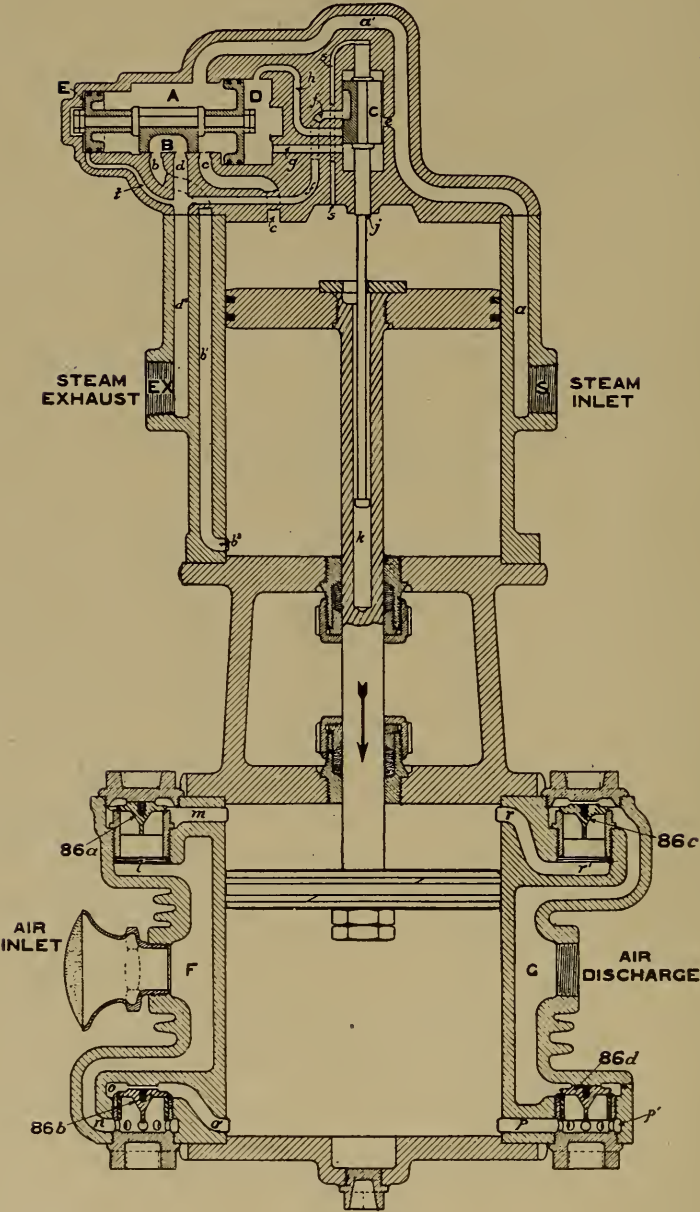


PLATE 7.

Engine oil should never be used in the air cylinder, as it will eventually clog and restrict the air passages, causing the pump to heat and destroy its efficiency. Valve oil will give the best results, and should be supplied through the cup provided for that purpose.

The pump should never be oiled through the air inlet or strainer, as this method of oiling tends to gum up the air valves and passages, and the cylinder receives but little benefit from the oil.

A swab well oiled on the pump piston is beneficial, as it keeps the piston rod packing lubricated, and also assists in lubricating the air cylinder.

SPEED OF THE PUMP.

When descending long grades, the pump throttle should be opened sufficiently to keep the pump running fast enough to maintain the required pressure in the main reservoir. At other times the pump should be run fast enough to maintain the pressure, and the pump governor allowed to stop it at frequent intervals. It should not be run with a wide open throttle unless necessary, in order to keep up the required pressure.

The maximum speed of an air pump should not exceed 120 single strokes per minute. A higher speed is detrimental to good service, as it does not allow the cylinder to fill with air at each stroke, and would eventually cause the pump to run hot.

The pump should not be run too slowly, as this allows the air that is being compressed to leak past the packing rings, preventing the air to enter the cylinder from the atmosphere in the regular manner.

The pump should not be run while the engine is standing over an ash pit or other places where it is likely to draw dust or other foreign matter into the air cylinder.

DEFECTS OF THE EIGHT AND NINE AND ONE-HALF-INCH PUMPS.

One of the frequent causes of stoppage of the 8-inch pump is the failure of oil to reach the reversing piston 23, which is due to its location. The trouble can be remedied by removing the reversing cylinder cap 21 (Plate 3) and oiling the piston with valve oil. Before oiling, packing rings 24 should be examined, to ascertain whether they are in good condition.

A broken reversing piston rod will cause a complete stoppage. Loose nuts on top or bottom of the main steam valve, the reversing plate 18, or the button on the lower end of reversing rod 17 becoming badly worn so that it fails to pull down the reversing valve, will also cause the pump to stop.

Common causes of a pump stopping on the upward stroke are, a worn reversing plate 18, a worn shoulder on the reversing rod, broken stop pin 50, which would allow the packing rings to expand so that the pump could not be reversed, piston 23 stuck in the bushing, or loose studs 51 on the reversing plate.

If the pump stops on the down stroke it may be due to nuts 58 being off air piston 11, the button broken off of lower end of rod 17, or packing rings becoming displaced in reversing piston 23.

If the nuts 58 are off the air piston, the bottom head should be removed and the nuts replaced. To prevent the piston from turning while replacing the nuts, cap nut 21 should be removed and the throttle of the pump opened slightly to admit a little steam to the top head.

By the removal of cap nut 21, the steam which is admitted to the top of piston 23 is allowed to escape to the atmosphere. The large piston valve 7 overcomes the small piston valve, admitting steam to the top head of the pump, thus forcing the main piston downward and holding it in that position.

If the packing rings of piston 23 are broken, the broken parts

should be removed and candle wicking substituted, cap nut 21 replaced and the pump started.

If a pump stops before the maximum pressure is attained, the pump throttle should be shut off entirely for a few seconds and then opened quickly. If steam blows through to the exhaust and the pump fails to start, the main valve is probably broken. If the pump starts, but frequently stops again, the cap nut should be removed and the parts oiled with valve oil, the cap replaced and the pump started slowly. If this fails to start the pump the reversing piston side cap should be removed, the packing rings examined to ascertain if they are broken, and if found broken the broken pieces should be removed and well-oiled candle wicking used as a substitute. If this valve is found to be in good condition the center cap should be removed and the reversing valve and stem pulled out, noting whether the reversing plate is solid. If these parts are in good condition they should be replaced, care being taken to put the valve in facing the reversing piston, pushing the stem down to its extreme limits and replacing the cap. If the pump now starts and makes one complete stroke up and down and again stops, the trouble may be caused by the working loose of the piston nut in the air end of the pump. The bottom air head should then be removed, the nut tightened up and the head replaced.

Defective Air Valves. If the discharge valve is defective it will be manifested in the following ways:

First.—By the pump working rapidly, but not pumping much air, the air from one end of the pump only being forced into the main reservoir.

Second.—By an uneven stroke of the pump, the stroke moving away from the defective valve being the more rapid.

Third.—Only a small volume of air will be drawn in at the inlet ports while the pump is making the quick stroke.

In testing for this defect it can be determined by the air gauge, or by stopping the pump, opening the oil cups and removing the plug at the bottom of the cylinder head. If air con-

tinues to blow through the oil cup the upper discharge valve is leaking, while if air continues to blow through the opening in the cylinder head the lower discharge valve is leaking.

In testing the air valves of an 8-inch pump, the hand should be held lightly over the air inlet ports; if the air is drawn in and then forced out again at the upper or lower inlets it will indicate which valve is defective.

If the receiving valve in the 9½-inch pump leaks, the hand should be placed lightly over the strainer. The suction will be decidedly less while the pump is making the quick stroke, and the defective valve will be the one toward which the piston is traveling.

If an air valve sticks it will be indicated, first, by an uneven stroke of the pump; second, the pump will usually pound during the fast stroke; third, the pump will heat; fourth, there will be no suction at the air inlet port during one stroke of the pump.

When testing for this defect, the hand should be placed lightly upon the air inlet; if the stroke of the pump is uneven and there is no suction when the pump is making the slow stroke, the receiving valve at the end of the cylinder from which the piston is moving is stuck shut, but if there is a suction when the pump is making the slow stroke, and no suction when it is making the fast stroke, the discharge valve at the end of the cylinder from which the piston is moving is stuck open.

To remedy this defect the cages should be tapped lightly, and if this does not start the valve the air inlet strainer W should be removed in order to see whether the trouble is at that point. If the pump still fails to work properly, an examination of the air valves should be made.

If one of the discharge valves is broken it should be replaced with a new one, if there is one on hand; if not, the receiving valve should be taken out and used to replace the broken discharge valve. This refers only to pumps in which all air valves are interchangeable, as with the 9½-inch pump. The changing of the air valves is necessary in order that the pump may not

labor against main reservoir pressure, which would be constant at one end of the piston, causing the pump to heat, and the constant pressure on the air piston would tend to leak past the packing rings and destroy the vacuum in the opposite end of the cylinder. The changing of the valves will cause the pump to give good service during one stroke, and cold air will be drawn in through the broken receiving valve, which will prevent heating.

The indication on the air gauge will show whether it is the receiving or discharge valve which is broken. If, when the brake valve is in running position, the red hand of the air gauge is raised and lowered at each stroke of the pump, it indicates that a discharge valve is broken or stuck open; but if the red hand is raised once while the pump is making two strokes it indicates that a receiving valve is broken or stuck open.

The pump will compress air in one direction only if any one of the four air valves is stuck or broken, the passages leading to or from the pump are stopped up, the piston rod packing blown out on the air end of the pump, the cylinder head plug gone, a cylinder head leaking on either end, or a top discharge valve bushing is loose on a $9\frac{1}{2}$ or 11-inch pump.

Leaky Air Piston Packing Rings. Leaky air piston packing rings will cause a pump to heat more quickly and become more troublesome than any other cause, due to the churning of the air in the cylinders. This defect can be detected by running the pump at a moderate speed and placing the hand lightly, so as not to exclude the air, over the air inlet ports, as air is drawn into the cylinder during the beginning or first half of each stroke, the cylinder being filled the balance of the stroke by air leaking past the defective rings.

Failure of Pump to Restart Promptly. If the air supply is not maintained by reason of the pump failing to restart promptly, reduce the air pressure which the governor controls, and if the pump starts to work it indicates that the trouble is in the governor. If it does not start the fault is in the pump.

How to Tighten a Loose Reversing Plate. In order to tighten a loose reversing plate the top head of the pump should be removed, the cylinder head plug also removed, and a stick or rod used to shove the piston to the top end of its stroke. The reversing plate should then be fastened, and the reversing rod, top head and the lower cylinder head plug replaced.

Heating of the Pump. Heating of the pump is often caused by badly gummed air valves, clogged ports due to the excessive use of oil in the air cylinder, which becomes mixed with dust that is drawn into the cylinder through the strainer, badly worn packing rings, racing of the pump, or pumping against a high pressure.

Leakages and Blows in Eight-inch Pump. With an 8-inch pump (Plate 3), if the reversing valve 16 or its seat becomes worn so that it leaks, steam will flow through ports *c*, *f*, *f* and *g* to the exhaust, causing a constant blow.

If the packing rings in either piston leak, steam will constantly escape by them into ports *f*, *f*, *f*, *f*, and thence into port *g*.

Badly worn, broken or defective piston packing rings cause a constant heavy blow which is wasteful, as one end of the cylinder is always open direct to the exhaust, and the other end is always full of steam, thus giving a non-interrupted passage of the steam to the atmosphere. Defective packing rings should receive immediate attention.

Leakages and Blows in the Nine and One-half or Eleven-inch Pump. If slide valve 83 (Plate 4) leaks, it will cause a constant blow through the exhaust while the pump is working.

If the packing rings of piston valve 79 (Plate 4) become worn or broken, causing them to leak, the result will be a constant blow, as steam will leak past piston 79, into chamber E, through port *t*, which is always open to the atmosphere through the exhaust.

A leak in the gasket forming the joint between the top cylinder head and the cylinder will allow steam to pass from the supply passage directly through to the exhaust passage, but this

seldom occurs without steam leaking to the atmosphere around the outside of the head, where it can readily be seen. This defect can be remedied by renewing the gasket.

If the reversing valve (Plate 7) leaks, there will be a constant blow of steam through port *f* into exhaust port *d*.

If the top end of reversing rod 71 (Plate 6) becomes worn so that steam leaks past into port S and thence down through the reversing valve bushing passage into the top cylinder of the pump, it will cause a blow while the pump is making the upward stroke, as the exhaust passage of that end of the pump is then open.

Pump Pounding. A pump will pound if it is not fastened firmly to its frame, if the air valves are stuck, or if there is too great a lift in the air valves. It will also pound if the reversing plate is badly worn and fails to reverse the pump at the proper point, or if the nuts on the piston are loose. The defects mentioned are the chief ones which cause pounding.

THE EIGHT AND ONE-HALF-INCH CROSS-COMPOUND AIR COMPRESSOR.

The building of more powerful locomotives with the ability to handle the long trains now in daily service throughout the country, as well as the large brake cylinders required for heavy freight and passenger cars of modern construction, have increased the demand for compressed air to such an extent that greater pump capacity has become essential on many roads where service conditions are especially severe. To meet this demand an air compressor of the cross-compound type has been developed. This type is not only of ample capacity for any railroad service, but in point of efficiency and economy in steam consumption it is a decided improvement over the present 9½ and 11-inch air pumps. Plate 8 shows a photographic view, and Plate 9, Figs. 1 and 2, shows diagrammatic views of the air compressor.

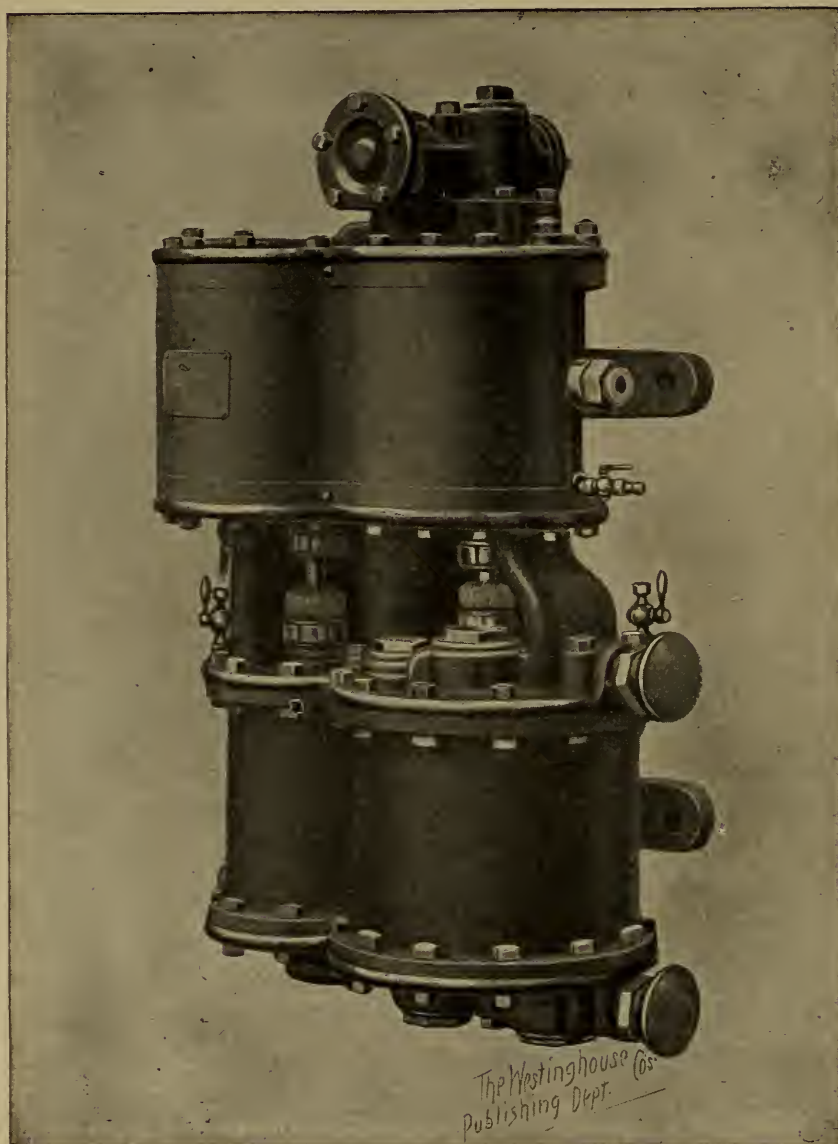


PLATE 8.

Operation—Steam End. Referring to Plate 9, Figs. 1 and 2, steam enters passage *a* and passes to the top head, thence through passage *b* to the chamber above slide valve 72; also through port *j* into the chamber above reversing valve 22. Consequently when the governor is open and steam is turned on at the compressor throttle, steam pressure is always present above slide valve 72 and reversing valve 22. When the high pressure steam piston is at the bottom of its stroke, the reversing valve is in the position shown on Plate 9, Fig. 1. Port *n* is then uncovered, allowing the steam to flow to the chamber at the left of the large main valve piston 26. Port *m*, which also connects this chamber with the reversing valve seat, is closed by the reversing valve. Port *o* is always in communication with port *p* and the exhaust passage *e* at one end, and the cylinder back of the small main valve piston 28 at the other end, so that the small main valve piston 28 always has exhaust pressure on its outer face. Since live steam is always in the chamber above slide valve 72 and exerts its pressure against the inner surface of both main valve pistons 26 and 28, and the larger piston now has full steam pressure on its outer face through port *n*, the resulting pressure on it will be balanced, while the small piston has steam pressure on its inner face and exhaust on its outer, so that it will be forced to the right to the position shown on Plate 9, Fig. 1. Live steam can then pass through port *k*, which connects with the slide valve chamber at the side of the valve, and port *g* in the slide valve seat, leading to the bottom of the high pressure steam cylinder. At the same time, the top of the high pressure steam cylinder is connected, through port *c* in the slide valve seat, ports *h'* and *h* in the slide valve, and port *d* in the slide valve seat, with the top of the low pressure steam cylinder. The high pressure steam beneath steam piston 7 will force it upward, while the steam above it will expand into the low pressure steam cylinder, forcing piston 8 downward.

As the high pressure piston 7 approaches the upper end of its stroke, reversing plate 18 strikes the shoulder on reversing

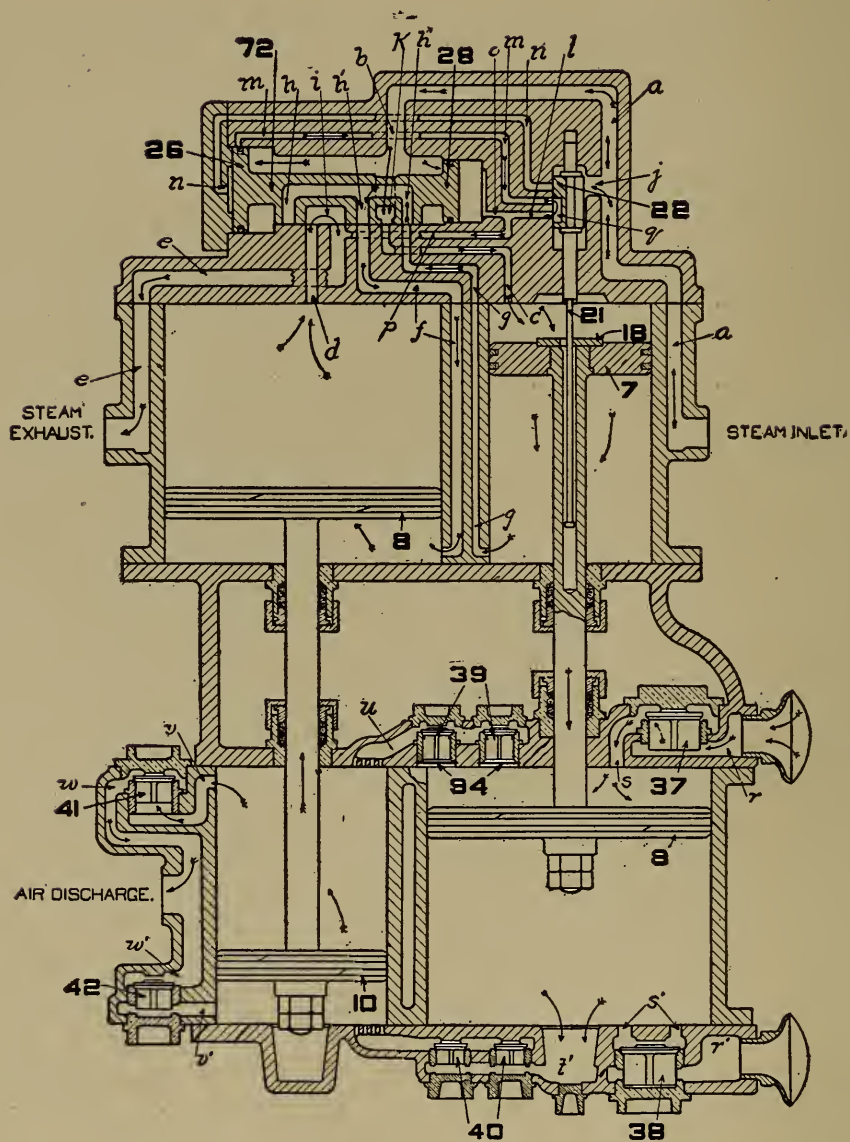
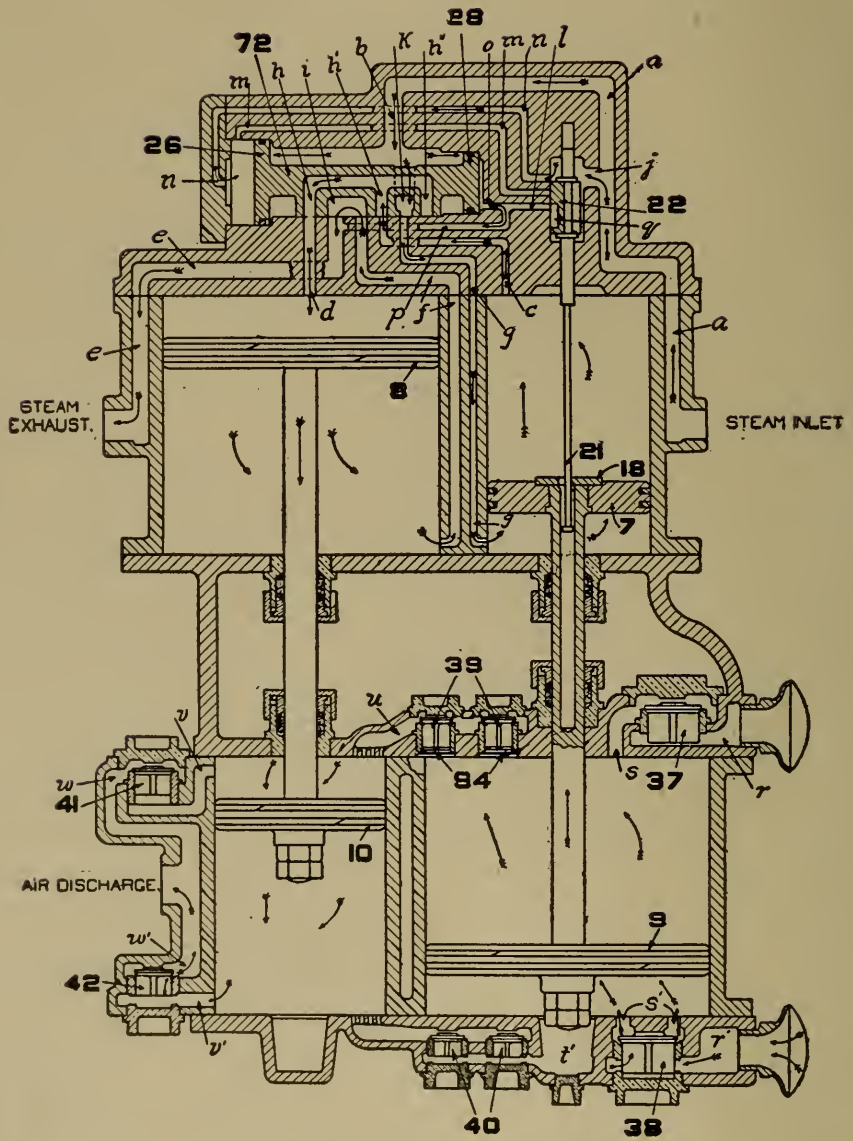


PLATE 9—FIGURE 1.

valve rod 21, forcing it and reversing valve 22 upward. This movement closes port *n*, preventing any further flow of steam to the back of the large main valve piston. It also connects ports *m* and *l* by cavity *q* in the face of the reversing valve. Port *l* connects through port *p* with exhaust passage *e*, so that the chamber at the left of the large main valve piston 26 is connected to the exhaust.

Under these conditions the outer faces of both main valve pistons are subject to exhaust pressure, while their inner faces have steam pressure as before. Since piston 26 is larger in diameter than piston 28, an excess of pressure exists toward the left, which moves pistons and main valve to the position shown on Plate 9, Fig. 2. It will be noted that port *m* enters the chamber at the left of the large main valve piston at a point which is not quite at the end of the chamber. This port is located at this point so that piston 26, when moving to the left, will close it before the piston reaches the limit of its movement. As port *n* is then closed by the reversing valve a small amount of steam is entrapped, which serves as a cushion to prevent this piston from striking the chamber cover. Port *c* in the valve seat now connects with port *k* in the main valve, so that live steam can pass to the top of the high pressure steam cylinder. At the same time, the bottom of the high pressure steam cylinder is connected through port *g* in the valve seat, ports *h''* and *h'* in the slide valve, and port *f* in the slide valve seat, to the bottom of the low pressure cylinder. The top of the low pressure cylinder communicates through the cavity *i* in the slide valve and ports *d* and *e* in the seat with the exhaust. The high pressure steam piston is then forced downward by the steam entering through ports *k* and *c* from the boiler, and the low pressure piston is forced upward by the steam in the bottom of the high pressure steam cylinder expanding through ports *g*, *h''*, *h'* and *f*, into the bottom of the low pressure cylinder, while the low pressure steam above the piston passes out to the atmosphere through port *d*, cavity *i*, port *e* and the exhaust pipe connection.



When the high pressure steam piston 7 reaches the bottom of its stroke, the reversing valve plate 18 strikes the bottom on the lower end of reversing valve rod 21, pulling it and reversing valve 22 downward to the position shown on Plate 9, Fig. 1. Connection between ports *l* and *m* is again broken by the reversing valve 22 and port *n* opened. Thus the chamber at the left of the large main valve piston 26 receives full steam pressure, equalizing the pressures on the two sides of that piston, and making the preponderance of steam pressure on the inner face of the small main valve piston force both pistons and slide valve to the right, when live steam is again admitted below the high pressure piston 7 and the steam above the piston is connected to the top of the low pressure steam cylinder. The bottom of the low pressure steam cylinder is also connected through cavity *i* in the slide valve, and the ports *f* and *e* in the slide valve seat to the exhaust, so that the high pressure steam piston will start upward and the low pressure steam piston will be forced downward. Thus a complete cycle of the steam end of the compressor is finished.

Operation—Air End. When the high pressure steam piston is forced upward, the low pressure air piston 9, being connected to the same piston rod, is also drawn upward, and air is drawn in through the lower suction strainer into the lower passage *r'* (Plate 9, Fig. 1). The inlet valve 38 then lifts and the air passes into the cylinder through port *s'*. When this piston reaches the upper limit of its stroke, and starts downward, inlet valve 38 is forced to its seat, and the air below the piston is compressed until it can raise intermediate valves 40, when it is forced through ports *t'* and *u'* to the lower end of the high pressure air cylinder, the piston of which is being drawn upward in the meantime. When the low pressure air piston 9 reaches the lower limit of its stroke and starts upward, the intermediate valves 40 drop to their seat so that air from the high pressure air cylinder cannot flow back into the low pressure air cylinder. At the same time the high pressure piston 10 is forced downward by the low pressure steam

piston, compressing the air that has been forced into the lower high pressure air cylinder from the low pressure side, until it is raised to a sufficient pressure to enable it to lift discharge valve 41, when it will be forced through port v' and passage w' to the air discharge connection. In this way the air is compressed in two stages, the intermediate pressure resulting from compressing the low pressure air cylinder which is filled with air at atmospheric pressure into the smaller high pressure air cylinder. The intermediate pressure which will result depends on the ratio of the low pressure to the high pressure cylinders, and is greatest at the end of the stroke. The air drawn in through the upper suction strainer to the top of the low pressure air cylinder passes through the compressor in exactly the same manner as that just described for the lower end, and, as the ports are lettered alike, its passage can readily be traced from the inlet to the discharge. It should be noted that the intermediate pressure above mentioned is independent of the delivery or main reservoir air pressure as long as the latter is the greater. This intermediate pressure is about 40 pounds.

DEFECTS OF THE COMPRESSOR.

A defective receiving valve 37 or 38 can be detected by holding the hand on or close to the strainer of these valves while the pressure piston is moving toward it. If it leaks, air will be felt blowing past it.

If the compressor fails to restart promptly, after being stopped by the governor, the intermediate and discharge valves should be examined and ground in if found to be leaking.

Leakage past final discharge valves 41 and 42 can be detected by the slower movement of both the low and the high pressure pistons toward the leaky valve, and the quicker movement of the high pressure piston away from it.

If too much oil is given to the low pressure cylinder it will collect on the intermediate air discharge valve, and will probably cause it to stick open.

If the air pump runs hot it may be due to leaks by the piston

rod packing; a leaky intermediate discharge valve; a leaky receiving valve; badly worn packing rings in the air end of the pump, or racing the pump under a high steam pressure.

Other defects of the cross-compound air compressor are similar to those of the 9½-inch pump previously described.

THE MAIN RESERVOIR.

The principal purpose of the main reservoir is to afford an ample storage space for a supply of compressed air sufficiently large to release and recharge the brakes quickly. It also serves to entrap any dirt, water or other foreign substance which may be carried into the reservoir with the air, preventing them from being conveyed into the brake valve, triple valves and brake cylinders. The reservoir should be drained at frequent intervals.

The atmosphere contains a great deal of moisture or water, which is carried in suspension. The greater the quantity of air compressed in a given space, the greater the amount of water which will accumulate. If no place were provided for the water to collect it would be carried with the current of air throughout the entire air system, preventing the brakes from working properly and freezing in winter, thus putting the entire brake system out of service. Only a small amount of this water results from leakage past the piston rod of the cylinder. The neglect of the engineman to drain the main reservoirs has been the direct cause of many air brake failures. An accumulation of water in the main reservoir is also a frequent cause of brakes sticking, especially on long trains, as the water takes up space in the reservoir that should be occupied by air.

Capacity. The capacity of main reservoirs varies from 20,000 to 66,000 cubic inches.

Leakage. Leakage is about the only defect which the main reservoir is subject to, but a leak will very rarely be found in the reservoir itself. All the piping from the pump and from the reservoir to the brake valve is considered as part of the reservoir, and it is in these pipes that the leaks usually occur.

WESTINGHOUSE AIR PUMP GOVERNORS.

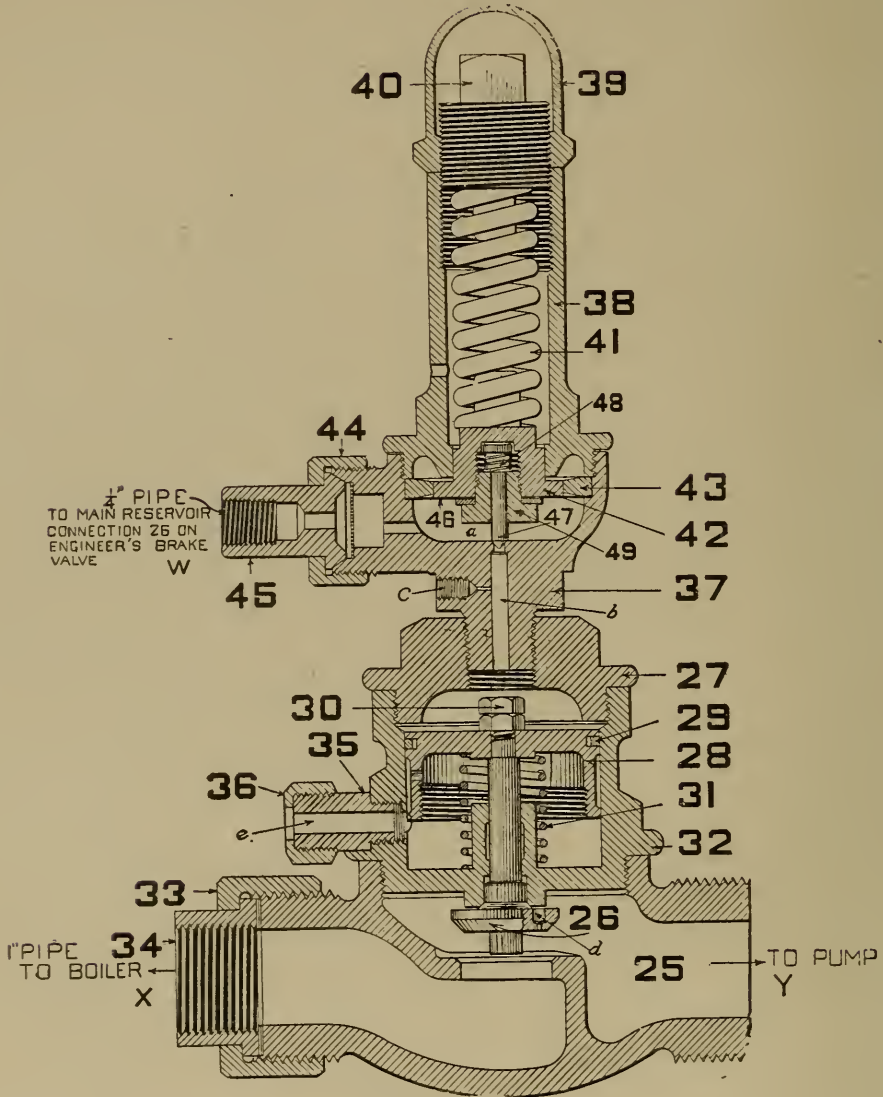


PLATE 10.

AIR PUMP GOVERNOR—SINGLE.

The location of the air pump governor in the brake system is shown on Plate 2.

By following the direction of the arrows shown on Plate 10, which is a cross sectional view of the pump governor with the

valves in their normal position, it will be seen that the steam has a free passage from connection X to Y.

Operation. The purpose of the governor is to cut off the steam supply, and thus practically stop the pump, when the desired air pressure in the main reservoir and brake pipe has been attained. The air pressure connection to the governor is at W. The adjustment of the governor is regulated by means of adjusting nut 40, which regulates the tension of spring 41 upon diaphragm 42. When the tension of spring 41 is greater than the air pressure in chamber *a*, the diaphragm holds the small pin valve 47 upon its seat; but when the air pressure underneath diaphragm 42 becomes greater than the tension of spring 41, the diaphragm is raised, unseating the small pin valve. Air from chamber *a* then flows through passage *b* into the chamber above piston 28, and forces it downward, seating steam valve 26, and shutting off the steam supply from the pump.

Whenever the air pressure becomes reduced, through leakage or otherwise, spring 41 forces diaphragm 42 downward and the pin valve 47 is again seated. The air in the chamber above piston 28 then escapes to the atmosphere through the small relief port C, and spring 31, assisted by the steam pressure below valve 26, raises piston 28 to its normal position, as shown on Plate 10, and the pump resumes operation.

During the time that the pin valve is unseated, there is a continuous escape of air to the atmosphere through relief port C. This leakage, in conjunction with the leakage of steam through the small port *d* through steam valve 26, serves to keep the pump operating slowly, thus avoiding trouble from the condensation of steam, which would otherwise accumulate.

Number 35 is a drip pipe connection to the chamber immediately below piston 28. Its purpose is to permit any steam that may leak past the steam valve 26 or any air that may leak past piston 28 to escape to the atmosphere. To guard against the drip pipe freezing, the pipe leading from the connection E should be made as short as practicable.

DUPLEX PUMP GOVERNOR WITH SIAMESE FITTINGS.

Plate 11 shows a sectional view of the duplex pump governor. By comparing Plate 11 with Plate 10 it will be seen that both the diaphragm bodies and the steam valve body of the duplex governor are exactly the same as the corresponding parts of the single governor. The only difference between the two governors is that the duplex governor is provided with the Siamese fitting and an extra diaphragm case. This governor is nothing more than a combination of two diaphragm bodies with one steam valve body, and it operates in the same manner as the single governor. Only one of the diaphragms acts at a time, and therefore no further description is necessary. Connection B of the pump governor leads to the boiler; connection P leads to the pump; connection MR leads to the main reservoir, and BV to the brake valve, as shown on Plate 11.

On the D-8 brake valve the W connection leads to the brake pipe instead of the main reservoir.

The normal position of the pump governor is open, as shown on Plate 11.

Cleaning and Changing Pressures. When for the purpose of cleaning it becomes necessary to relieve the pressure on a governor, which is connected directly to the brake pipe, with a D-8 brake valve, the cut-out cock below the brake valve should be turned and the pump shut off. The brake valve should be put in service position, the pressure drained from the governor, the tension on the regulating spring released, the spring casing removed and the governor cleaned with a piece of soft wood.

To reduce the pressure with a single governor, with a G-6 brake valve, the cut-out cock below the valve should be turned, the main drum pressure drained either by using the bleed cock or taking off the handle of the brake valve, turning it upside down and turning the rotary so as to bring the large supply port *a* in communication with the direct application and emergency port. Or, the main reservoir can be drained by placing the brake valve

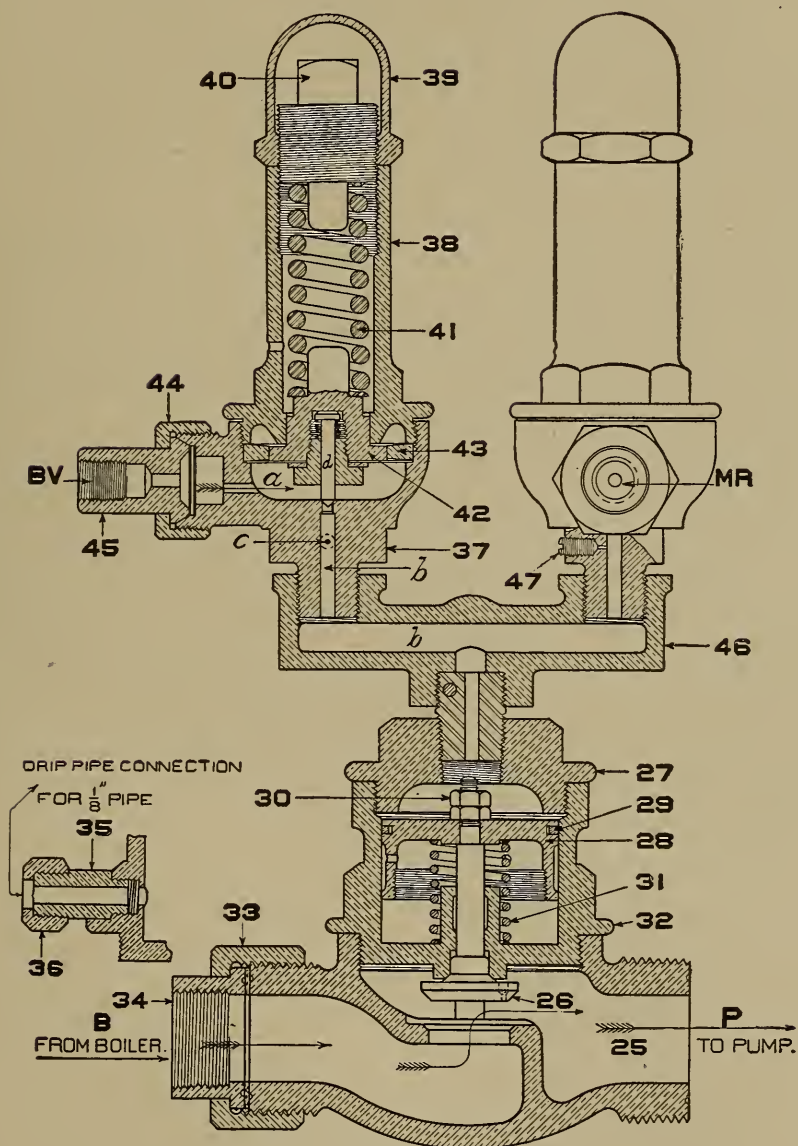


PLATE 11.

handle in full release position and opening the angle cock on the rear of the tender. The first and second methods of draining are preferable, as foreign matter is not drawn through the brake valve. The tension of the regulating spring should then be released, the spring box disconnected from the governor body and the governor cleaned.

The low pressure governor of the duplex, with the G-6 brake valve, in freight service, can be cleaned in the same manner as the governor with the D-8 brake valve.

The pressure can be reduced from the high pressure governors of the duplex and the high speed in the same manner as the single governor with the G-6 brake valve previously described.

To relieve the pressure from the low pressure governor of the high speed brake valve, the cut-out cock in the low pressure piping to the governor should be turned, and in all cases when the pressure of the governor is relieved the pump should be shut off when the pressure of the main drum is drained through the angle cock, and the brake valve should be reported as cleaned on the completion of the trip.

Governor Inoperative. If the low pressure of the duplex governor in freight service becomes inoperative, a blind gasket should be placed in the pipe connections leading to the low pressure governor and the high pressure governor regulated to carry the required excess pressure.

If the high pressure governor becomes inoperative, a blind gasket should be placed in the pipe connections leading to the high pressure governor and the pump throttled while the brake valve is on lap or in service position, or the piping can be changed from the high pressure to the low pressure governor and from the low pressure to the high pressure governor, and a blind gasket placed in the pipe connections of the high pressure governor.

The low pressure governor should then be regulated to carry the required excess pressure.

If the high pressure governor of the high speed brake is in-

operative, a blind gasket should be placed in the pipe connection leading to the high pressure governor, the low pressure governor then cut in and regulated to carry the high pressure required by the high speed brake.

If the low pressure governor is defective, the cut-out cock in the pipe connection leading to the low pressure governor should be turned and the high pressure governor regulated to carry either the low or the high pressure as may be desired.

Governor Cut Out. If the governor will not allow maximum pressure to be attained after all remedies have been applied as previously described, the air pipe leading to the governor should be disconnected, a blind gasket inserted between the pipe connections and the governor or the pipe connections at the brake valve, and the throttle used to regulate the speed of the pump during the remainder of the trip.

DEFECTS OF PUMP GOVERNORS.

If pin valve 47 leaks, it will allow air pressure to flow in on top of air piston 28. If the leakage is greater than the amount of air escaping from the relief port C, the pressure will force the air piston down and completely stop the pump.

Leaks in the governor can be detected by noting whether the air is escaping out of vent port C when the pump is working, which would indicate that the pin valve 47 is held from its seat by foreign matter. If no air blows out of vent port C, it should be noted whether air is leaking by the spring casing where it is attached to the body of the governor, or whether air is leaking out of the vent port in the spring casing, which would indicate a leak past diaphragm 42.

If the governor allows too high a pressure, it may be due to the tension of regulating spring 41 being set too high, a leak by diaphragm 42 with the port in the spring casing stopped up, the strainer in the pipe connection to the governor becoming stopped up, the passageway leading from the pipe connection to

the chamber being stopped, passageway *b* becoming stopped up, governor piston 28 becoming stuck in the bushing, a stopped up waste pipe, scales under steam valve 26, steam valve becoming badly cut, pin valve 47 being too long, the head being off the pin valve, or spring 48 broken. Any one of these defects will prevent the governor from operating and will allow the pump to continue working.

If the pump stops before the maximum pressure has been reached it may be due to the tension of the regulating spring 41 being too weak, or the spring broken, pin valve 47 being held from its seat by foreign matter, or vent port C being stopped up.

To distinguish whether the trouble is in the pump or the governor, if the pressure is not maintained, the pressure which controls the governor should be reduced. If the pump goes to work the fault is in the governor, but if the pump does not go to work all pressures should be reduced on the governor before attributing the fault to the pump.

DUPLEX AIR GAUGE.

The duplex air gauge shows simultaneously the pressures in the main reservoir and the brake pipe. One hand (usually colored red) indicates the main reservoir pressure, while the other (colored black) shows the brake pipe pressure. It is in reality two gauges combined in one, the same dial serving for both hands.



PLATE 12—FIGURE 1.

Description and Operation. Plate 12, Fig. 1, shows an exterior and Fig. 2 an interior view of the Westinghouse Duplex Air Gauge. Fig. 2 shows two bent tubes, A and B, elliptical in shape. Tube B is connected to the fitting T, and tube A to fitting M. The bottom ends of the tubes are held fast and the top ends are sealed and free to move. Their action is thus explained. If a tube or an elliptical section is bent, and then filled with internal pressure, the force will tend to straighten the tube. This is due to the fact that an inner force of pressure tends to make the tube round. In assuming the round form, the concave side A of the bent tube tends to lengthen while the convex side tends to shorten. These combined effects tend to straighten the tube outward and impart a movement to the free end. Tube A is connected to one end of lever *k*; *g* by means of link *c*. This lever

is pivoted at *e* and the end *j* has the form of a toothed sector which meshes with a pinion on spindle *i*. Spindle *i* carries the red hand of the gauge and rotates within a hollow spindle *l*, which carries the black hand. Tube B is connected by link *b* to levers *f* and *g* at a point below the fulcrum or pivot, so that the black hand will be turned in the same direction as the red one.

The lower ends of *f* and *g* have the form of a toothed sector which meshes with a pinion on hollow spindle *l* and operates the black hand.

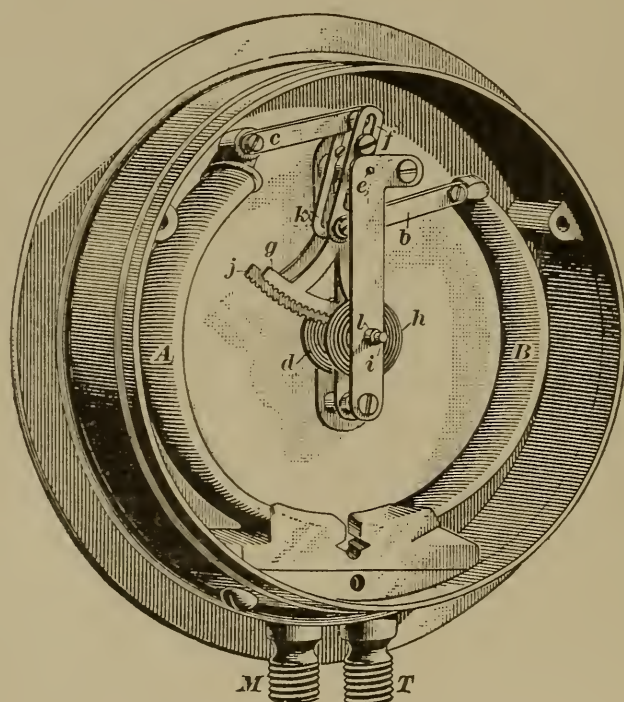


FIGURE 2—PLATE 12.

Testing Gauge. The air gauge can be tested by placing the brake valve in full release position and watching the gauge while the pressure is being pumped up. If both hands do not move up together the gauge is out of order, as when the brake valve is in this position the main reservoir and brake pipe pressures remain equal. The two hands should register alike, but if they register within three pounds of each other the gauge may be considered as approximately correct.

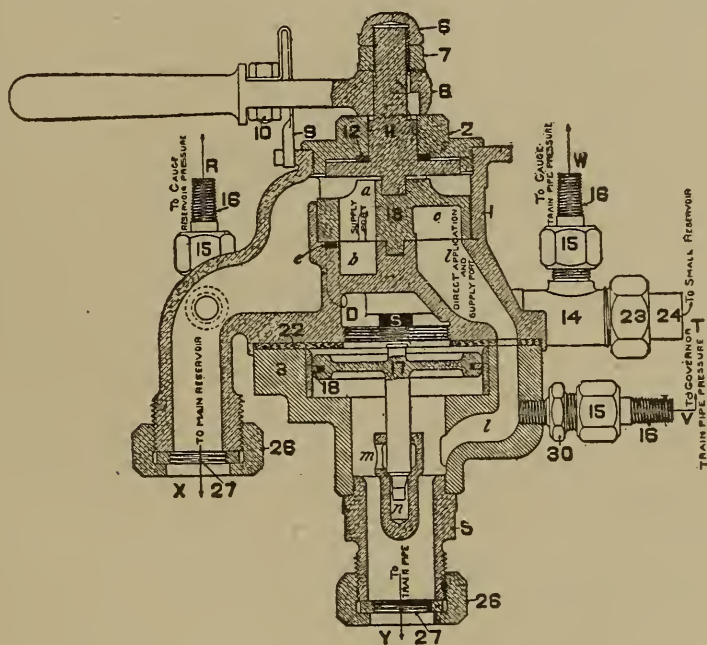
ENGINEER'S BRAKE VALVES.

THE D-8 BRAKE VALVE.

The D-8 brake valve, being one of the old types of valves, has been superseded to a great extent by the more modern brake valves, causing the old types to become nearly obsolete, though still used to some extent on small engines.

Plates 13 and 15 are sectional views of the brake valve in release position. Plate 14 is a plan view of the rotary valve seat.

A pipe connected at R (Plate 13) leads to the red hand con-

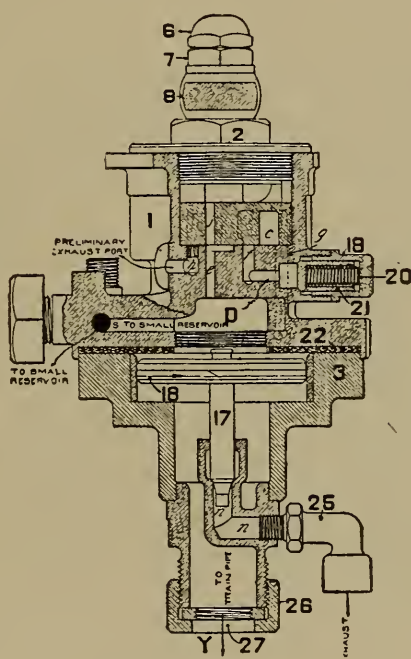


"D-8" ENGINEER'S BRAKE VALVE.

PLATE 13.

nection of the air gauge, and a pipe from W leads to the black hand connection. The pipe secured at T leads to the equalizing reservoir and the pipe from V connects the brake pipe with the pump governor. The brake pipe is connected at Y and air from the main reservoir enters the brake valve at X, and always has access to the chamber above rotary valve 13, its further course being governed by the position of the rotary valve.

of seventy pounds will exist in the main reservoir and throughout the brake system, and the governor will cause the pump to stop. The pump governor, being connected to the brake pipe, is adjusted to cut off the steam supply as soon as the full brake pipe pressure has been secured. To obtain excess pressure in the main reservoir the brake valve handle must be moved to running position.



"D-8" ENGINEER'S BRAKE VALVE.

PLATE 15.

Running Position. When the brake valve is in running position, port *j* of the rotary valve registers with passage *f*, leading to excess pressure valve 21, which is held to its seat by excess pressure spring 20, the tension of which is equal to a pressure of 20 pounds per square inch. Air from the main reservoir flows through port *j* into passage *f*, where it encounters the excess pressure valve, which is held to its seat by brake pipe pressure and spring 20. When the pressure in passage *f* exceeds that in the

brake pipe by more than twenty pounds, the excess pressure valve is forced from its seat, compressing spring 20, and the air flows through passages *f* and *l* into the brake pipe, as shown on Plate 14. Port *g*, leading through the rotary valve seat to chamber D, still communicates with cavity *c*, which also overlaps passage *l*, causing equalizations of the pressure in the brake pipe and chamber D, the latter being connected with the equalizing reservoir as previously explained. With the brake valve handle in running position, the pump governor will cut off the steam supply when the brake pipe pressure reaches seventy pounds, but the interposition of the excess pressure valve has caused a pressure twenty pounds greater than that in the brake pipe to accumulate in the main reservoir, so that the main reservoir pressure is ninety pounds.

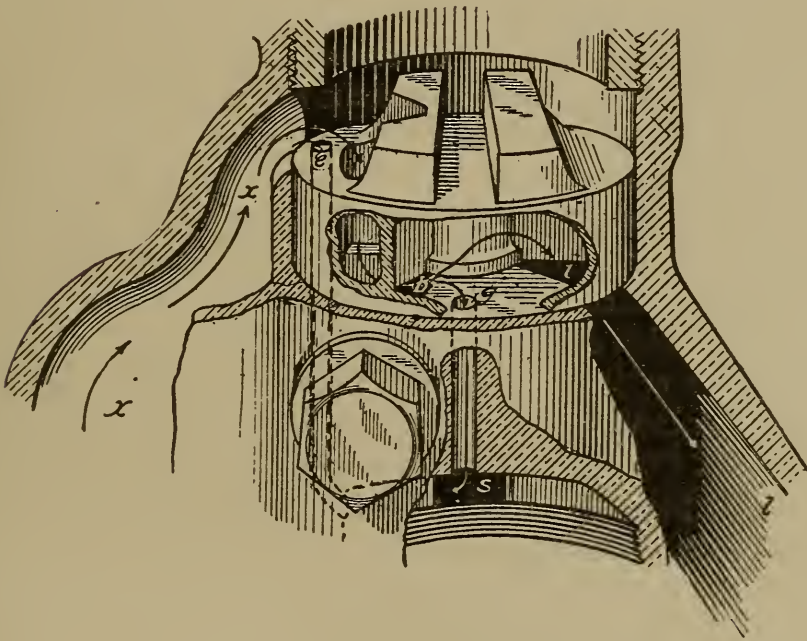
Lap Position. When the rotary valve is in lap position, all ports are operatively blanked. If the pump is started with the valve in this position no air can reach the brake pipe to operate the pump governor, and the pump will continue working until the main reservoir pressure has become about equal to the steam pressure in the boiler.

Service Application Position. When the valve is in this position, communication between the main reservoir and the brake pipe, and also between the brake pipe and chamber D, is cut off, and the cavity in the lower face of the rotary valve connects port *e* with the small preliminary exhaust port *h*, whereby air is discharged from chamber D to the atmosphere. The resultant reduced pressure in chamber D and the equalizing reservoir permits the greater brake pipe pressure below the equalizing piston to raise it, unseating the brake pipe discharge valve. The brake pipe air then discharges through passage *n* into the atmosphere until the pressure becomes a trifle less than the pressure remaining in chamber D, which forces the piston downward, reseating the valve.

Emergency Application Position. While the brake valve is in this position, cavity *c* of rotary valve 13 overlaps both the

large "direct application and supply port" *l* and "direct application and exhaust port" *k*. A large direct passage is thus provided for quickly discharging brake pipe pressure to the atmosphere, and the resulting sudden reduction of brake pipe pressure causes an emergency application of the brake.

Port *e* is slotted to the right (Plate 14), this slot being pro-



"D-S" ENGINEER'S BRAKE VALVE.

RELEASE POSITION.

PLATE 16.

vided in order that there may be no position between the release and running positions, in which communication between the main reservoir and the brake pipe is wholly cut off. If the rotary valve is so moved that port *j* is above the space between ports *e* and *f*, main reservoir air can still feed through the slotted port into chamber *D*, thence through port *g*, into cavity *c* of the rotary valve and through passage *l* into the brake pipe at *Y*.

Port *e* also serves to allow the main reservoir pressure to reach chamber D above the equalizing piston when the valve handle is being moved to release position. The connection is established as soon as port *j* in the rotary valve comes into register with slotted port *e* in the rotary valve seat.

Pressures. When the brake valve is in full release position there is one large direct opening leading from the main reservoir to the brake pipe, and two small ports open leading to chamber D (Plate 16).

There will be a pressure of seventy pounds accumulated in the main reservoir, chamber D and the brake pipe if the pump is started with the valve in this position.

When the brake valve is moved to running position, air cannot pass to the brake pipe until excess pressure has been attained. In order for the air to pass to the brake pipe it must unseat the excess pressure valve, which cannot be done until the air pressure exceeds the tension of the valve spring.

When this style of valve is in running position, there is a pressure of ninety pounds in the main reservoir and seventy pounds in the brake pipe. As soon as these pressures have been attained, the pump governor, which is controlled by brake pipe pressure, stops the pump.

If the pump is started with the valve in running position, the red hand will go up to twenty pounds before the black hand moves. They should continue to raise twenty pounds apart, and stop with the red hand at ninety and the black hand at seventy pounds.

DEFECTS OF THE D-8 BRAKE VALVE.

If the rotary or excess pressure valve leaks, the pump, after stopping, will not start again until the brake pipe and main reservoir pressures have been reduced below seventy pounds, or the pressure at which the governor is set.

If no air will pass into the brake pipe when the brake valve is in running position, the trouble will be due to the excess pres-

sure valve being stuck to its seat. When this occurs, the handle of the brake valve should be placed in full release position until the valve and chamber can be cleaned.

If the red hand stands at eighty and the black hand at seventy pounds, when the pump stops, and the valve is in running position, the excess pressure spring is too weak. But if the red hand registers over ninety and the black hand at seventy pounds, the excess pressure spring is too strong.

If the excess shows less than twenty pounds it should be adjusted. The cut-out cock below the brake valve should be turned, the brake valve placed in service position, the pump shut off and the spring taken out and pulled apart or stretched, so as to lengthen it, which will strengthen it. Or, a washer can be placed between the cap and the spring, to increase the tension.

If the excess pressure is over twenty pounds it is evident that the spring is too long, or rather too strong. When this occurs a piece should be cut off the spring, and it is better to make several small cuts than one large one, or too much may be taken off by the first cut.

At whatever pressure the pump governor may stop the pump, as long as the main reservoir pressure is twenty pounds in excess of the brake pipe pressure, the excess pressure spring has the right tension.

If the red hand stands at eighty and the black hand at sixty pounds or the red hand at one hundred and the black hand at eighty pounds, it indicates that the pump governor needs adjusting.

If the brake valve fails to maintain excess pressure, the difficulty is caused either by a leaky rotary valve or by dirt accumulating on the seat of excess pressure valve 21.

Distinguishing Leaks. A leaky rotary valve can be distinguished from a leaky excess pressure valve by placing the brake valve in lap position. If the pressure continues to equalize it will be a leaky rotary, but if the pressure does not equalize the trouble will be caused by a leaky excess pressure valve.

Gauge Indications. When the brake valve handle is midway between the service and full emergency positions the black hand may show main reservoir pressure, although it is known by the position of the valve that there is no air in the brake pipe. This indication is due to the construction of the valve. When it is in this position, port *j* of the rotary stands over port *g* in the rotary seat, which leads to chamber D. Chamber D is charged to main reservoir pressure and the black hand registers chamber D pressure.

EQUALIZING RESERVOIR.

The small equalizing reservoir or brake valve reservoir, commonly called the little drum (Plate 17), is usually placed under the cab footboard. A pipe leads from this small drum to the engineer's valve which is connected at T, as shown on Plate 13. The air can then pass through port *s* and chamber D. The equal-

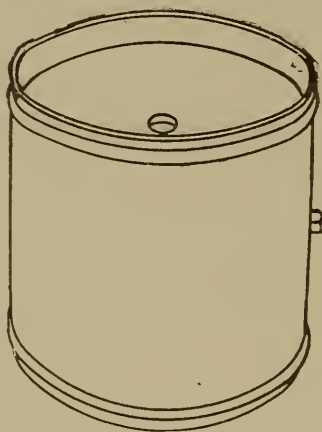


PLATE 17.

izing reservoir serves to increase the capacity of chamber D, without an enlargement of the engineer's brake valve. Chamber D being of a small capacity, it would be impossible to make a gradual service application of the brakes without the increased volume furnished by the little drum.

The black hand of the air gauge is connected at the brake valve, and it therefore indicates chamber D and brake pipe pressures. The equalizing piston 17 separates chamber D from the brake pipe pressure. The pressure in chamber D acts in holding the equalizing piston down, and brake pipe pressure tends to force it upward.

Purpose of the Small Drum. The purpose of the small drum is to increase the volume of air on top of the equalizing piston in the engineer's brake valve. The air in the small cavity over the equalizing piston is sufficient to hold the piston to its seat, but there is not a sufficient volume to draw from when making a service reduction.

If the engineer's brake valve was placed in service position and there was no equalizing reservoir to furnish an additional volume of air on top of the equalizing piston, the small volume of air on top of the piston would be exhausted in a flash, the black hand on the gauge would fall to the pin, the equalizing piston would raise full stroke and all of the brake pipe pressure would rush to the atmosphere through the brake pipe exhaust, causing the engineman to lose control of the brakes.

Time Consumed for Preliminary Exhaust. When a service application of the brakes is made it will ordinarily take from five to seven seconds to reduce chamber D pressure from seventy to fifty pounds, depending on the size of the equalizing reservoir.

DEFECTS OF THE EQUALIZING RESERVOIR AND ITS CONNECTING PARTS.

If the reduction from chamber D takes place too slowly it may be due to the preliminary exhaust port being partly stopped up, packing rings in equalizing piston leaking, gasket 32 leaking from main reservoir to chamber D, with the G-6 valve, or gasket 22 leaking from the brake pipe to chamber D, with the D-8 brake valve.

If there is too rapid a reduction from chamber D it may be due to a leak in the pipe connection to the gauge, the bleeder in

the small drum leaking, or the drum being partly filled with water, the preliminary port *e* being too large, or the choke being partly stopped up between chamber D and the small drum.

Cutting Out the Drum. If the small drum springs a leak while on the road, a plug or a blind gasket should be put in the connection leading to it and the brake pipe exhaust plugged. The brake valve can then be used in the emergency application position for making service stops. The valve should be moved to the emergency port carefully in order to avoid quick action. When a service reduction has been made and the brake valve is being returned to lap position, it should be done carefully, in order to allow the port to be closed slowly and the surge of air from the rear portion of the brake pipe to escape to the atmosphere slowly, thus preventing the kicking off of the brakes on the head end of the train, which would otherwise cause the train to part, in addition to losing the braking power of the brakes so released.

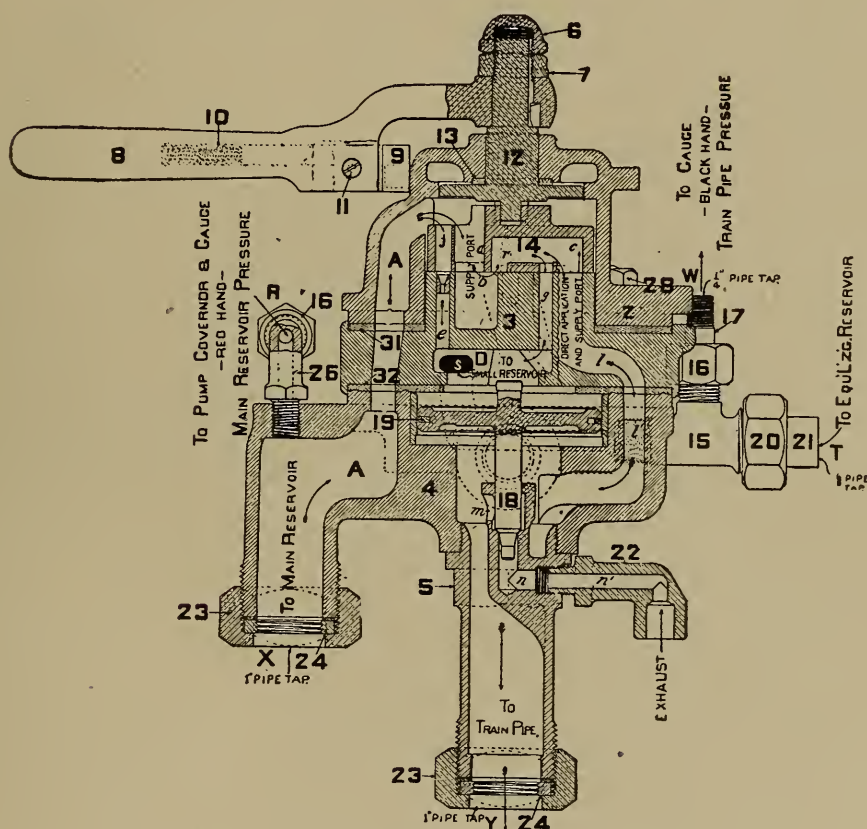
THE G-6 ENGINEER'S BRAKE VALVE.

The D-5, E-6 and F-6 brake valves are practically identical, the different letters and figures simply referring to the same valve. The G-6 valve is also the same, except that the slide valve feed valve supplants the former feed valve attachment.

Before describing the operation of the brake valve, it may be of benefit to the reader to define a few terms which are in common use.

Excess Pressure. The difference between the pressure in the main reservoir and that in the brake pipe is usually from twenty to sixty pounds, when the train brake apparatus is fully charged. Excess pressure combined with an abundance of main reservoir capacity insures prompt release and recharging. The amount of excess pressure to be carried is determined by the character of the road, length of train and size of main reservoir.

Air Gauge Connections. The red hand of the gauge connection is piped to R (Plate 18), and indicates main reservoir pressure. A tee is usually inserted in this pipe for a pipe connection to the pump governor, which is generally adjusted to cut off the steam supply when the main reservoir pressure has reached ninety pounds. The black hand of the gauge connection is piped to W,



"G-6" ENGINEER'S BRAKE VALVE.

PLATE 18.

and is directly connected to the equalizing reservoir; this hand also indicates the brake pipe pressure. The black hand is usually referred to as the brake pipe, and the red hand as the main reservoir pressure.

Standard Pressures. The customary standard brake pipe pressure is seventy pounds, while ninety pounds is considered as standard main reservoir pressure, but these pressures may be modified to meet special conditions. In the following description seventy pounds will be considered the standard brake pipe pressure and ninety pounds the standard main reservoir pressure.

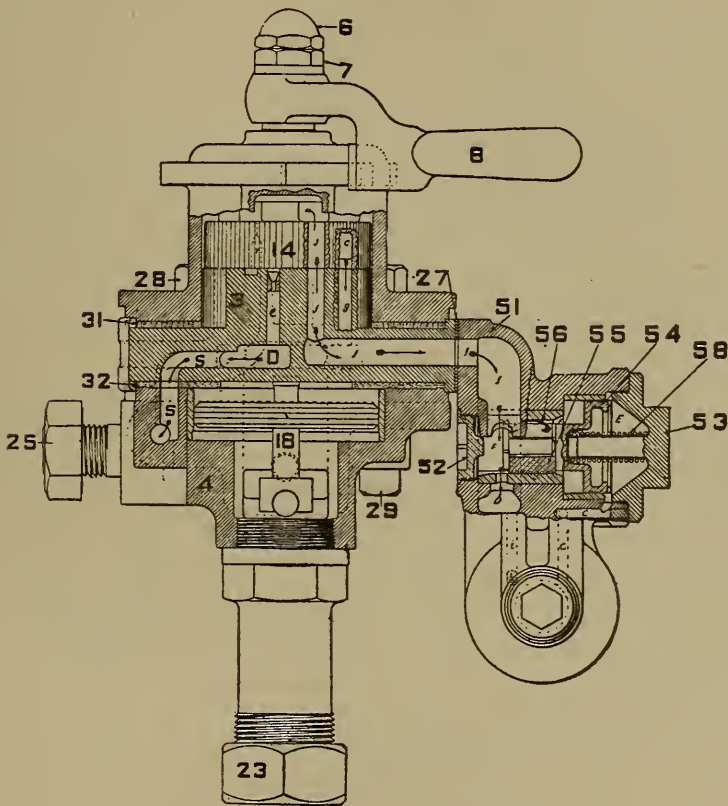
Release Position. The purpose of this position is to provide a large and direct passage from the main reservoir to the brake pipe, thereby permitting a rapid flow of air into the latter, and insuring a quick release and recharging of the brakes. Release is the position shown on Plate 18. By referring to Plate 2, it will be seen that a pipe leads from the main reservoir to the brake valve. It is connected at X (Plate 18), and when the brake valve is in release position main reservoir air flows through passage A to the chamber above rotary valve 14, thence through port *a* in that valve, cavity *b* in its seat 3, cavity *c* in the valve (which overlaps cavity *b*) and passage *l, l'*, to the brake pipe at Y. Port *g*, being then also exposed to cavity *c*, simultaneously conducts air into chamber D above equalizing piston 18. By means of passage S and a pipe connected at T, chamber D is always in open communication with the equalizing reservoir shown on Plate 2. Port *j* of the rotary valve registers with port *e* in its seat, and air is also conducted through these ports to chamber D. It thus occurs that in release position two small ports feed the equalizing reservoir and one large port supplies the brake pipe.

The purpose of the equalizing reservoir with this valve is to increase the volume of chamber D above piston 18, and answers the same purpose as explained with the D-8 brake valve.

While the brake valve is in release position, warning port *r*, shown by the dotted lines (Plate 19), which is of very small area, discharges main reservoir pressure to the atmosphere with considerable noise, attracting the engineer's attention if he subsequently neglects to move the valve to running position. If this brake valve were allowed to remain in release position a pressure of ninety pounds would result, not only in the main reservoir,

but also in the equalizing reservoir, brake pipe and auxiliary reservoirs, as in this position they are all in direct communication with each other. To stop the escape of air through the warning port and to prevent overcharging of the brake system, the valve is moved to running position.

Running Position. This is the proper position of the brake

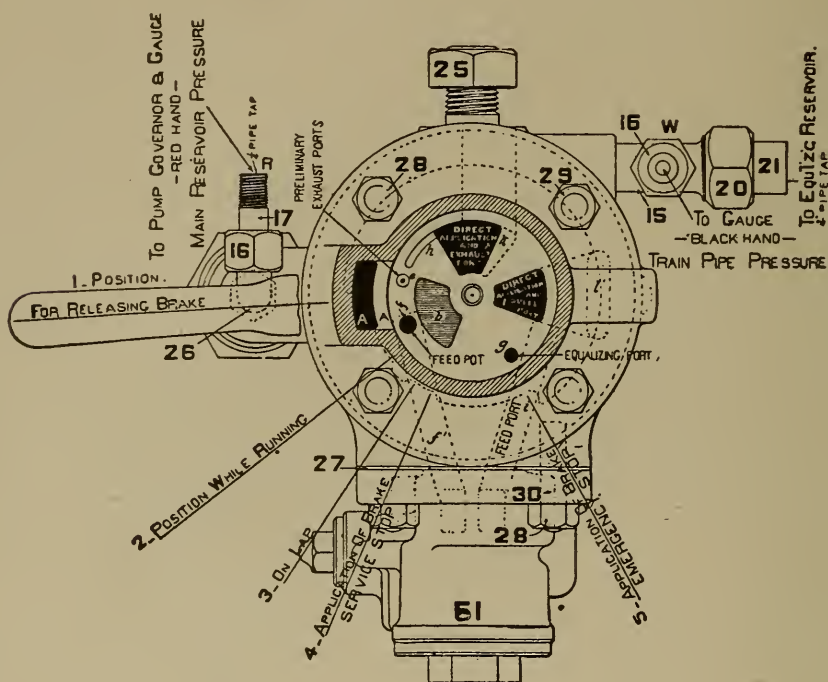


"G-6" ENGINEER'S BRAKE VALVE.

PLATE 19.

valve when the brake apparatus is charged and ready for application. In this position (shown on Plate 19), the main reservoir pressure attains the proper excess above that in the brake pipe. This pressure is always present in the chamber above rotary valve 14 and is conducted by port *j* and passages *f* and *f'* into

chamber F. Thence, as hereafter explained, its course is through the feed valve, from which it is conducted by passages *i*, *l* and *l'* into the brake pipe at Y (Plates 20 and 21). Port *g* still connects chamber D with cavity *c* of the rotary valve, and, as cavity *c* still overlaps passage *l*, the equalizing reservoir and brake pipe are directly connected. The same pressure consequently exists above and below equalizing piston 18. The feed valve is ad-



"G-6" ENGINEER'S BRAKE VALVE.
PLATE 20.

justed to cut off the air supply to the brake pipe when the pressure reaches seventy pounds. The pump governor will not stop the pump until the main reservoir pressure reaches ninety pounds.

Lap Position. This position, the second from release, is that in which all ports are operatively blanked. After the preliminary discharge of air for a service application of the brakes, the valve handle is placed in lap position until it is desired to make a further brake pipe reduction, or to release the brakes. If the

pump is started with the brake valve on "lap," the result will be a pressure of ninety pounds in the main reservoir and nothing in the brake pipe, when the pump is stopped by the governor.

Service Application Position. This position is the third from release, and is used to cause a service application. A groove in the lower face of rotary valve 14 connects port *e* with groove *h*

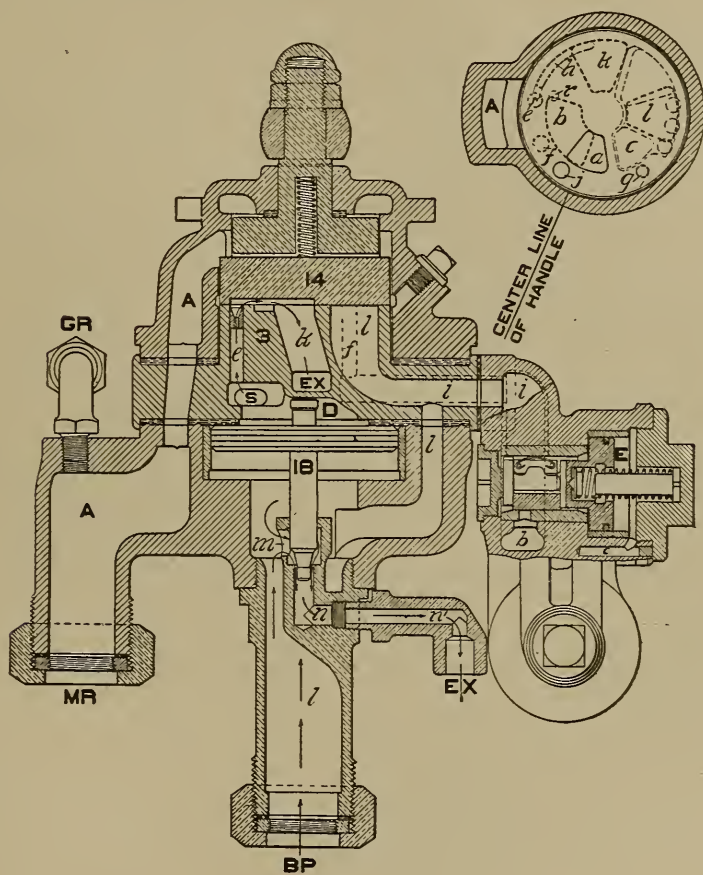


PLATE 21.

in its seat (Plate 21), causing air to be discharged from chamber D and the equalizing reservoir, through port *k* into the atmosphere, thus reducing the pressure above piston 18. The greater pressure in the brake pipe below the piston thereupon forces it upward and unseats the discharge valve, and brake pipe air discharges through port *m* and passages *n* and *n'* of the exhaust

fitting, into the atmosphere. The desired reduction of pressure in chamber D having been made, the valve is moved back to lap position. It is to be observed, however, that after the valve has been moved to this position, air will continue to discharge from the exhaust fitting, until the pressure in the brake pipe has been reduced to a trifle less than that in chamber D and the equalizing reservoir. Piston 18 then automatically forces the discharge

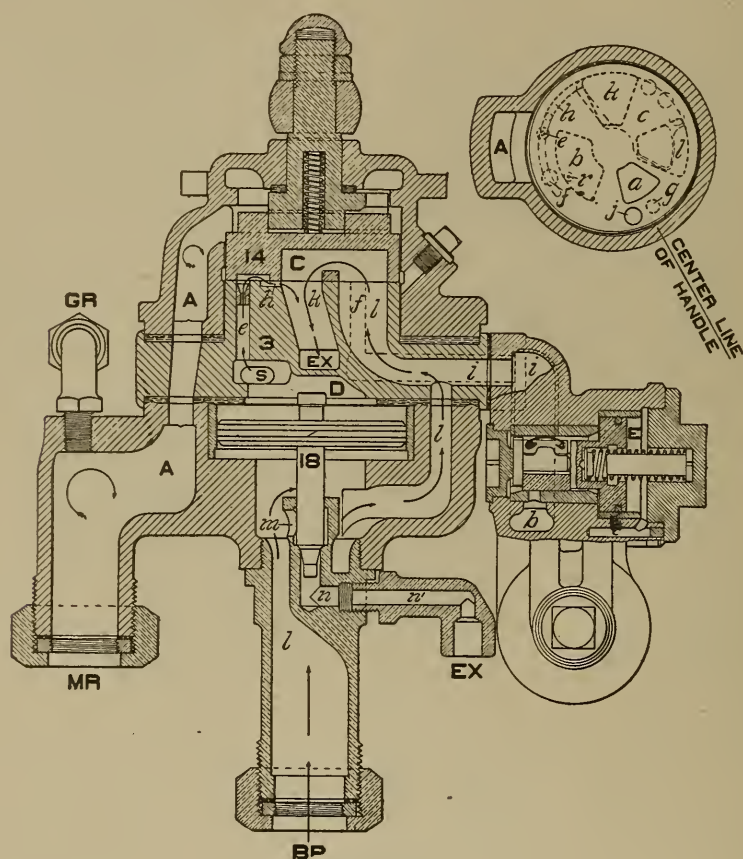


PLATE 22.

valve to its seat, through the action of the greater pressure upon its upper surface. Ordinarily a reduction of from five to eight pounds in brake pipe pressure is sufficient for an initial application of the brakes.

Emergency Application Position. This position, which is the farthest from release, is used for an emergency application of

the brakes. Direct application and exhaust port *k* and direct application and supply port *l* are directly connected by means of large cavity C in rotary valve 14, which in this position overlaps both, thus permitting a rapid discharge of brake pipe air through the large ports. The resulting sudden reduction of brake pipe pressure causes a nearly instantaneous application of the brakes throughout the train (Plate 22).

Difference in Types. The G-6 valve is the type most commonly used, but the D-8 type is also used to some extent, principally on light power. These two valves are alike in principle, and the same results are obtained by a differential construction of the valve, both valves having the same positions.

The difference in the pipe connections of the two valves is, that on the G-6 valve the pipe leading to the pump governor is connected with the main reservoir pressure, while on the D-8 it is connected with the brake pipe.

The G-6 has larger ports than the D-8 valve, and chamber D air is exhausted through the direct application and exhaust port; it also has a warning port in the rotary, and a feed valve, with the brake pipe governor connected to it.

Regulation of Pressures. If the red, or main reservoir gauge hand, with a G-6 brake valve shows a pressure that is too high or too low, it is the fault of the governor, and it should be regulated by means of adjusting screw 40. The tension of the screw should be slacked off for less excess pressure and tightened down for increased pressure.

If the black, or brake pipe gauge hand, shows too high or too low pressure, the feed valve needs regulating. Cap 66 should be taken off and regulating nut 65 adjusted until the brake pipe pressure stands at seventy pounds.

DEFECTS OF THE G-6 BRAKE VALVE.

When the brake valve handle is in running position and the brake pipe pressure gradually increases, it indicates that air is leaking from the main reservoir into the brake pipe. This may

be due to (1) the rotary valve leaking; (2) leaky gasket 32, allowing air to leak into chamber D and thence through the equalizing port to the brake pipe; (3) feed valve gasket 27 leaking; (4) diaphragm 43 leaking with vent port in spring box chamber 42 stopped up; (5) a leak past supply valve 34.

Leaky Rotary. A leaky rotary valve would destroy excess pressure, as it will allow the main reservoir pressure to feed by the bridge of the rotary into the brake pipe, thus equalizing the brake pipe pressure with that in the main reservoir. This defect is considered dangerous at all times, particularly so if the engineer is not aware of the leakage.

When applying the brakes with a leaky rotary, a sufficient reduction should be made to get the pistons past the leakage grooves, and a slight blow, sufficient to overcome the leakage from the main reservoir, should be allowed from the brake pipe exhaust, which will cause the black hand to fall gradually, until it is necessary to release the brakes or come to a stop.

When testing for a leaky rotary valve or valve seat, the engine should be detached from the train, the brakes should be set with a reduction of from ten to fifteen pounds and the brake valve placed in lap position. If the black hand gradually creeps up and the brake releases, the rotary valve is leaking.

Distinguishing Leaks. To distinguish between a leaky gasket 32 and a leaky rotary valve of the G-6 valve with the lone engine, the brake valve should be placed in service position, and all the pressure drained from the brake pipe and chamber D. If the blow continues at the direct application and emergency exhaust ports, the trouble is caused by gasket 32 allowing pressure to leak from the main reservoir across the gasket on top of equalizing piston 18. If the blow ceases at the emergency exhaust after the pressure has been reduced, and continues at the brake pipe exhaust, the trouble is due to a leaky rotary valve.

To distinguish between a leaky rotary valve and a leaky feed valve or gasket 27, the cut-out cock below the brake valve should be turned and the valve placed in lap position. If the pressures

equalize it is a leaky rotary valve. If the hands remain separated on lap position, it is the feed valve or gasket 27.

To distinguish between a leak from gasket 27 and one from the feed valve, the brake valve should be placed in service position and spring box 40, diaphragm and piston 45 removed. The brake valve should then be placed in running position. If air blows by supply valve 34 it is the supply valve that is leaking, but if air blows out of port *i* in the chamber B above piston 45, the leak is past gasket 27.

A leaky equalizing piston packing ring can be distinguished from a leak at gasket 32, or the preliminary port being partly stopped up, by placing the brake valve in lap position with full pressure in the brake pipe and chamber D, and opening the brake pipe angle cock, draining the brake pipe. The leaky piston packing ring will then allow chamber D pressure to flow into the brake pipe and the gauge will indicate the leakage. Or, with a long train, after a reduction has been made in chamber D, the engineer should note whether the black hand gradually raises during the escape of air at the brake pipe exhaust and stops raising when the brake pipe exhaust ceases. If it does, it indicates that the equalizing piston packing rings are leaking.

To distinguish a leaky gasket 32 from a partly stopped up preliminary port, place the brake valve in service position and draw off all of chamber D pressure. If the blow continues through the preliminary exhaust it indicates a leaky gasket 32, but if it ceases blowing it indicates a partly stopped up preliminary port.

If the preliminary reduction is longer than from five to seven seconds with a long train, the reduction in the brake pipe will take place so slowly that it will not get the pistons past the leakage grooves on the rear cars.

Equalizing Piston Packing Rings. If the packing rings are too tight, while reducing the pressure in chamber D, the brake pipe pressure will not respond until an unusually heavy reduction

in chamber D pressure has been made, when the equalizing piston will suddenly raise (which would be likely to cause quick action of the brakes with a short train) ; also when the brake valve is on lap and there is a leak in the brake pipe, the gauge will not indicate it.

The rotary valve, feed valve and excess pressure valve should be kept clean at all times in order that they may be in good working order, separating and maintaining their pressure properly.

THE OLD STYLE FEED VALVE.

Plate 23 shows what is now usually known as the old style feed valve.

When connected to the brake valve, passage *f'* registers with passage *f'* of the brake valve (Plate 19), and passage *i* registers with passage *i* of the brake valve, which passage is connected with the brake pipe by means of passage *l*, *l'* (Plate 19) into which it leads.

Piston 45 of the feed valve is subject to the upward pressure of regulating spring 39, and to the downward air pressure in chamber B above the piston. The tension of spring 39 is so adjusted by regulating nut 41 that a pressure of seventy pounds (or any desired brake pipe pressure at which it may be set) is necessary in chamber B to overcome it and force the piston down. An upward movement of the piston unseats supply valve 34, and a downward movement permits spring 35 to seat it. Chamber B always contains the same pressure as that in the brake pipe, as they are in open communication.

When the brake valve is in running position and the pressure in chamber B is less than seventy pounds, regulating spring 39 will raise piston 45 and unseat supply valve 34. Air from the main reservoir, coming through passage *f*, passes supply valve 34 into chamber B, and thence discharges, through passage *i* and the corresponding passage *i* in the brake valve, into the brake pipe.

When the pressure in the brake pipe and chamber B reaches

seventy pounds, it overcomes the tension of regulating spring 39 and forces piston 45 downward, allowing spring 35 to seat supply valve 34, and no further passage of air can take place through the feed valve until the pressure in chamber B and the brake pipe

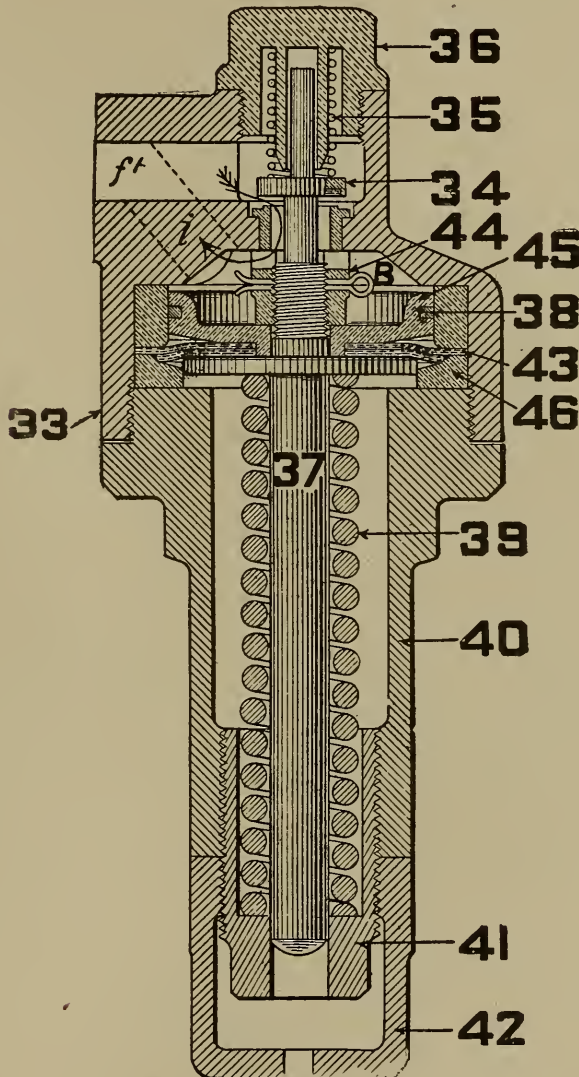


PLATE 23.

becomes, by leakage or otherwise, so reduced that the regulating spring can again force the piston upward and unseat the supply valve.

DEFECTS OF THE OLD STYLE FEED VALVE.

A leaky supply valve may be caused by a damaged or imperfect seat, or foreign matter on the seat. If the trouble is caused by dirt, the valve should be held under an open gauge cock and then wiped off with a piece of clean waste. It should never be scraped with a sharp instrument, as the valve seat is of soft metal, and the use of hard metal would be likely to scratch and ruin the seat. The best method of cleaning it is to use a piece of soft wood, with coal oil and waste.

To remove the valve, it will be necessary to proceed as with the excess pressure valve of the D-8 brake valve.

If spring box 40 (Plate 23) is screwed up too tightly, or carelessly, diaphragm 43 is likely to be pinched off, squeezed out, or arched up in such a manner as to prevent the upward and downward movement of feed valve piston 45, thus preventing the supply valve from seating and allowing the main reservoir pressure to flow unobstructedly into the brake pipe until the pressures are equal. This leak can be detected by a waste of air at the relief port at the bottom of cap nut 42.

If the feed valve fails to separate or maintain the proper pressures, after all efforts to remedy the defect have failed, supply valve 34 should be removed and the governor regulated to carry seventy pounds, or whatever brake pipe pressure is desired.

THE SLIDE VALVE FEED VALVE.

Plates 24 and 25 illustrate the device known as the slide valve feed valve, which may be used with either the D-5, E-6, F-6 or G-6 brake valve to maintain a predetermined brake pipe pressure while the brake valve is in running position.

Plate 24 shows a central section through the supply valve case and governor device, and Plate 25 shows a central section through the regulating valve and spring box, and a transverse section through the supply valve case.

Ports f' and i register with ports in the brake valve designated by similar letters on Plate 19, and in running position the main reservoir pressure constantly has free access through passages f' and f to chamber F. Chamber E, which is separated from cham-

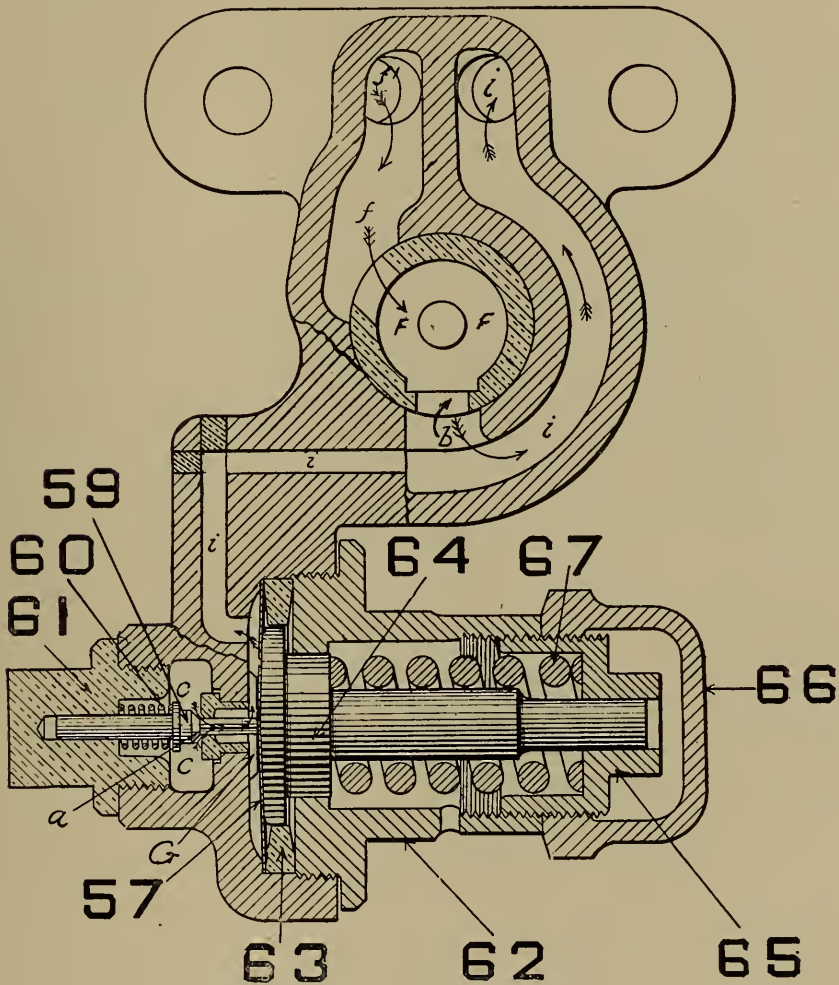


PLATE 24.

ber F by supply valve piston 54, is connected with passage i , and thus with the brake pipe, through passage c , c , port a and chamber G, above diaphragm 57. Regulating valve 59 is normally held open by diaphragm 57 and regulating spring 67, the

tension of which is adjusted by regulating nut 65, and when open chamber E is in communication with the brake pipe.

When the handle of the brake valve is in running position,

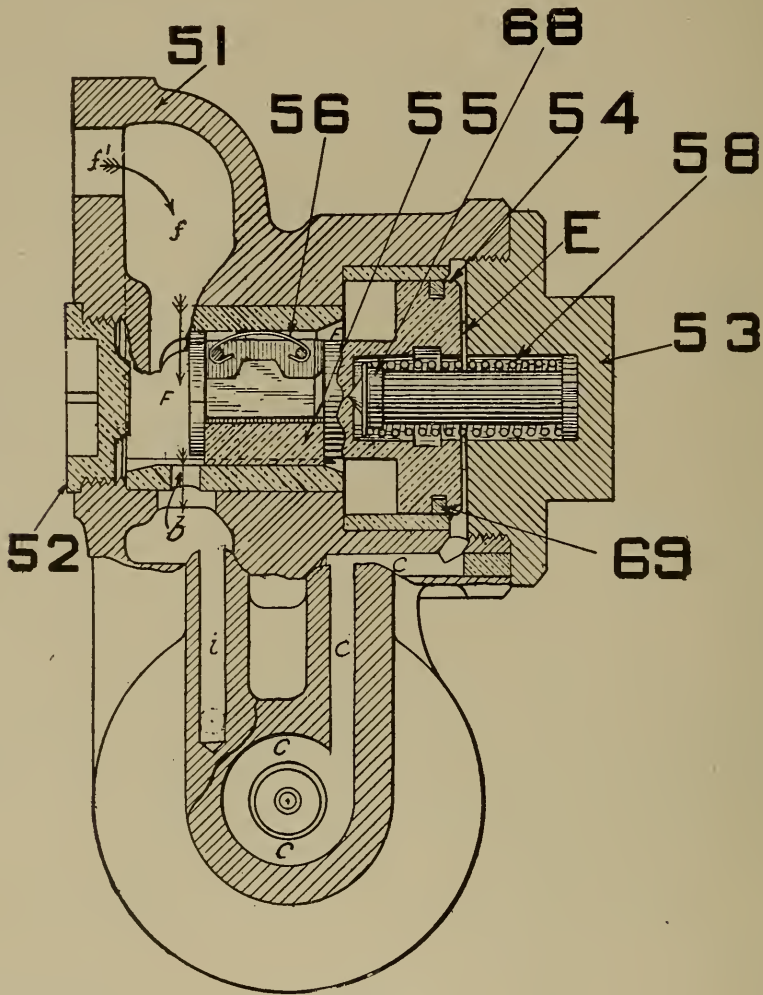


PLATE 25.

air pressure from the main reservoir in chamber F forces supply valve piston 54 forward, compressing its spring 58, carrying supply valve 55 with it and uncovering port *b*, thereby gaining entrance directly into the brake pipe through passage *i, i*. The resulting increase of pressure in the brake pipe and in chamber G

above diaphragm 57 continues until it becomes sufficient to overcome the tension of regulating spring 67, adjusted at seventy pounds. Diaphragm 57 then allows regulating valve 59 to be seated by spring 60, thus closing port *a*, and cutting off all communication between chamber E and the brake pipe. The pressures in chambers F and E then become equalized, through leakage past supply valve piston 54, and supply valve piston spring 58, which is compressed by the relatively high pressure in chamber F, now reacts and forces supply valve 55 to its normal position, closing port *b* and cutting off communication between the main reservoir and the brake pipe. A subsequent reduction of brake pipe pressure reduces the pressure in chamber G and permits regulating spring 67 to force regulating valve 59 from its seat, thereby causing the accumulated pressure in chamber E to discharge into the brake pipe. The equilibrium of pressure upon the opposite faces of supply valve piston 54 being thus destroyed, the higher main reservoir pressure in chamber F again forces it, together with supply valve 55, forward and recharges the brake pipe through port *b*.

The lower portion of the slide valve feed valve is in principle and construction almost identically the same as the feed valve of the F-6 brake valve, and is subject to the greater portion of the latter's defects. The slide valve, or its upper part, requires very little attention other than an occasional cleaning and oiling. In order to clean the feed valve while the system is charged with air, it is necessary to proceed as with other types of the Westinghouse brake valve.

DEFECTS OF THE SLIDE VALVE FEED VALVE.

Defects of this type of feed valve that will result in overcharging the brake pipe are, slide valve 55 held from its seat by foreign matter, face or seat of the valve cut, piston 54 stuck in the bushing with the slide valve open, the grooves of the loose fitting piston clogged up so as to make an air-tight fitting piston, spring 58 back of the piston chamber broken, cap nut 53 loose

and leaking so that the air in chamber E can escape to the atmosphere (this will also allow the main reservoir pressure to hold the slide valve off its seat), regulating valve 59 held off its seat by dirt, spring 60 broken, tension of regulating spring 67 too great, or a leak by diaphragm 57 with the hole in spring box 62 stopped up. Any of these defects will cause the brake pipe and main reservoir pressures to equalize.

Defects in the feed valve that will prevent main reservoir pressure from feeding to the brake pipe when the brake valve is in running position are, improper adjustment of regulating spring 67, passage *c, c*, behind piston 54 becoming stopped up, thus allowing the pressures in chambers E and F to equalize and, with the aid of spring 58, keep slide valve 55 closed, or piston 54 fitting too tightly in the bushing so that the main reservoir pressure cannot force it over and permit air to flow to the brake pipe. But if piston 54 is fitted too loosely in the bushing, a greater volume of air will pass the piston than can escape at regulating valve 59, and will result in holding supply valve 55 and piston 54 closed.

If the trouble is due to improper adjustment of regulating spring 67 it can be remedied by increasing the tension of the spring, but if it is due to passage *c, c*, being stopped up or piston 54 being stuck shut in the bushing, with the slide valve to its seat, piston 54 and slide valve 55 should be entirely removed, cap nut 53 replaced and the pump governor regulated so that it will stop the pump at seventy pounds. If the duplex governor is used the ninety-pound governor should be regulated to seventy pounds.

WESTINGHOUSE TRIPLE VALVES.

THE PLAIN TRIPLE VALVE.

The plain triple valve is now used on locomotives and tenders only, it having been superseded on all other classes of equipment by the quick action triple valve.

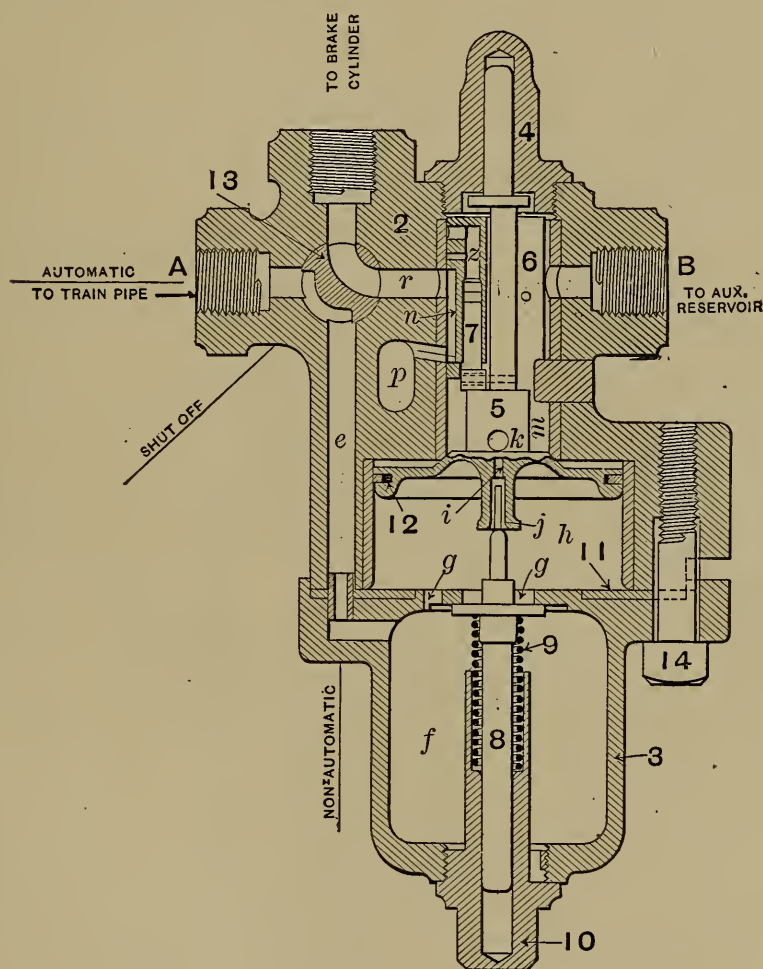


PLATE 26.

In the study of the triple valve, as well as other parts of the air brake or air signal equipment, a clearer understanding will result if one starts at the problem by first asking himself the question, which is the greater or controlling pressure acting on

the part in question? With this point thoroughly understood, the action of the parts under consideration can be readily traced; for example, if a brake pipe reduction is made, it is known that it will have the effect of lowering the pressure on the brake pipe side of the triple piston and cause the brake to apply. It is also known that when the brake pipe pressure is increased the tendency will be for the piston to move away from the greater brake pipe pressure, causing the brake to release.

The different parts of the plain triple valve are shown on Plate 26; 13 is the cut-out cock and handle; 8 the graduating stem; 9 the graduating spring; *i* and *k* are feed ports; 5 is the triple piston; 6 is the slide valve; 7 is the graduating valve, which works inside the slide valve; 12 is the piston packing ring. The pipe connections leading to and from the triple valve are also shown on Plate 26.

Valve 13 permits the triple to be used as automatic air, or to be cut out entirely.

The handle has two positions. The triple is cut in when the handle is standing at right angles to the triple. When the handle is placed at an angle of 45 degrees, ports *r* and *e* are blanked and the triple is cut out.

There are several other kinds of triple valves beside the old style plain triple with the cut-out cock in the body of the valve. The other plain triples are larger in proportion, with larger ports, and the cut-out cocks are in the cross-over pipe instead of in the body of the triple (Plates 27 and 28).

The normal position of the triple valve is release position, which allows the air to pass through the triple valve, charging the auxiliary reservoir. Air enters from the brake pipe connection (Plate 28), passes through port *e* into graduating stem casting *f*, thence through port *g* to chamber *h*. The piston being in release position and feed port *i* in the bushing being open, the air is free to pass to port *i* in the bushing and port *k* in the piston shoulder to chamber *m* and thence through the pipe connection to the auxiliary at R.

Service Application. In service application, the operation of the plain triple valve is precisely the same as that of the quick action valve, which will later be described in all its various positions. To apply the brakes for a service stop a gradual reduction

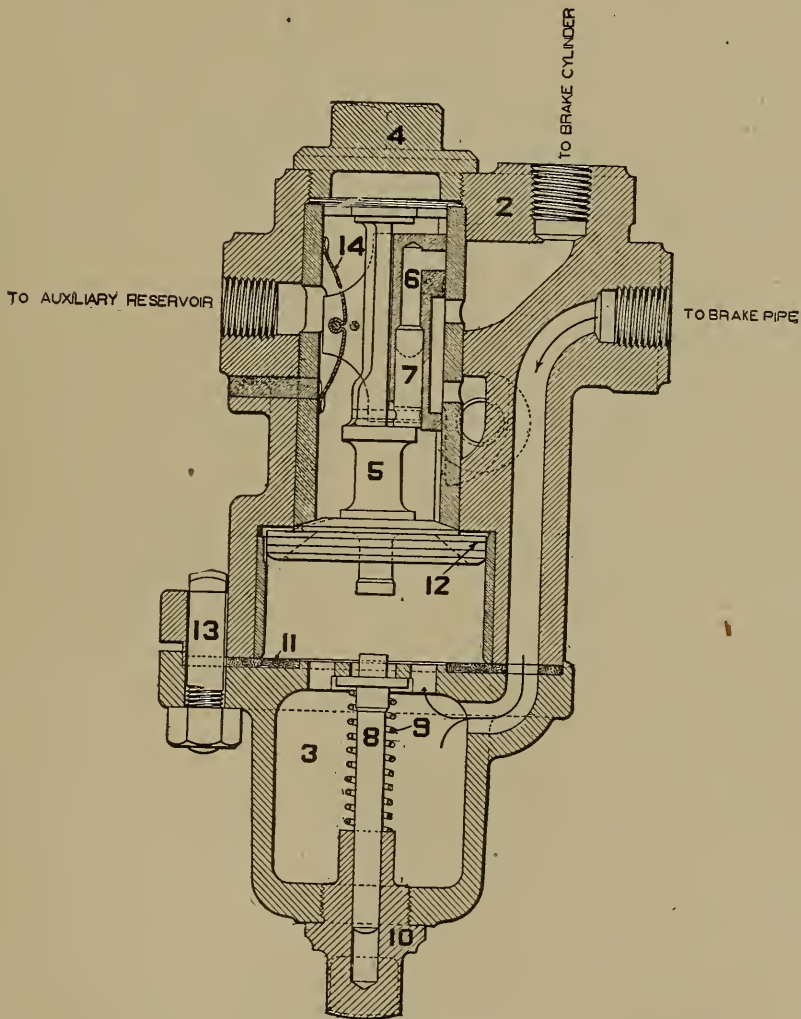


PLATE 27.

of brake pipe pressure is necessary, and for the purpose of illustration the first reduction will be assumed to be of five pounds, thus leaving a pressure of sixty-five pounds to act upon the brake

pipe face of main piston 5, while the original seventy pounds still acts upon the auxiliary reservoir face. As a result of this reduction the greater auxiliary reservoir pressure forces main piston 5 to the left. As the piston moves it closes feed grooves *i*, cutting off communication between the brake pipe and the auxiliary reservoir and unseats graduating valve 7, establishing communication between the transverse passages *w* and *z* of the slide valve, and when the graduating valve has become unseated, the collar at the end of piston stem *u* engages the slide valve, which is then drawn to the left during the further movement of the piston, thereby cutting off communication between exhaust cavity *n* in the slide valve and passage *r* leading to the brake cylinder. The movement of the main piston to the left is arrested by contact of its stem with graduating stem 8, which is held in position by graduating spring 9. In this position port *z* in the slide valve registers with port *r*, and auxiliary reservoir air flows through ports *w* and *z* of the slide valve and passage *r* to the brake cylinder. When the auxiliary reservoir pressure has become slightly less than that (sixty-five pounds) upon the brake pipe face of the main piston, the greater brake pipe pressure forces the piston back sufficiently to seat the graduating valve, which is known as lap position. If it is desired to apply the brakes with greater force, a further brake pipe reduction is made, which leaves the auxiliary pressure in excess of that in the brake pipe, and it again forces the main piston to the left and unseats graduating valve 7. The slide valve will not move, as the difference of pressure is just enough to overcome the friction of the piston and graduating valve, but not enough to overcome the friction of the slide valve. A corresponding further reduction of brake pipe pressure results in the discharge of auxiliary air to the brake cylinder. Such brake pipe reduction may be repeated until the auxiliary reservoir and brake cylinder pressures have finally become equalized, which will require a reduction of twenty pounds in the brake pipe. The brake is then fully applied and any further brake pipe reduction is but a waste of air.

Emergency Application. An emergency application is made by a sudden brake pipe reduction, which causes main piston 5 to move out so quickly that graduating spring 9 cannot withstand the impact of piston 5 against graduating stem 8, but yields so

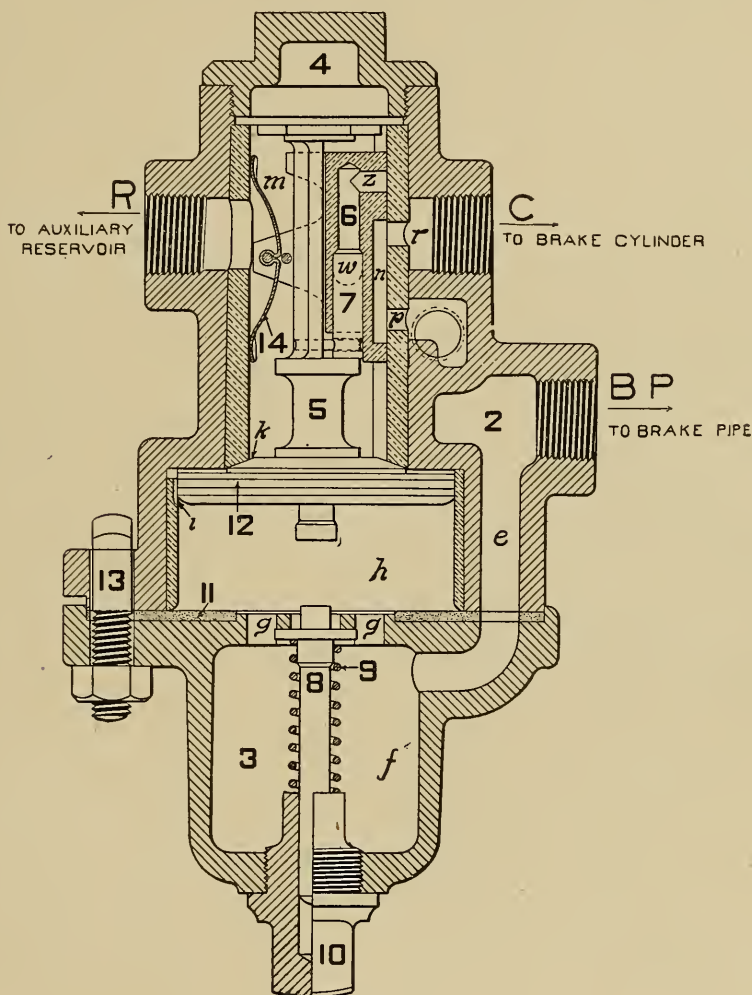


PLATE 28.

that the piston moves its full travel. In this position the upper edge of the slide valve is below the lower edge of the service port in the slide valve bushing, and an unobstructed communication between the auxiliary reservoir and the brake cylinder is secured through comparatively large ports. Instead of passing

through the slide valve passage, as in a service application, the air from the auxiliary reservoir entering the triple valve through a pipe connected at R, discharges directly into the brake cylinder through port *r*. During an emergency application, therefore, the less restricted passages cause the full brake cylinder pressure to take effect more promptly, but the absence of the emergency parts in the plain triple results in no quick serial action and no greater final brake cylinder pressure than may occur in a service application.

Release. To release the brakes the engineman admits main reservoir pressure into the brake pipe, thus increasing the pressure upon the brake pipe face of main piston 5 until it becomes greater than that upon the auxiliary reservoir face, and therefore forces the piston to its position at the extreme right. In this position the air in the brake cylinder is discharged through passage *r*, exhaust cavity *n*, into the slide valve and passage *p* to the atmosphere, either directly or through the pressure retaining valve when used. Feed groove *i* being again uncovered, the auxiliary reservoir becomes recharged.

Cut-Out Cocks. The plain triple valve (Plates 27 and 28) has not the old style cut-out cock in the body of the triple. The triple valve is the same, however, except that it has not this part. When the straight air brakes were superseded by the automatic, a lug was added to the four-way cock handle which will allow the brakes to be cut out of service if necessary, but it can no longer be converted into a straight air brake. On modern types of triple valves the cock has been entirely eliminated and replaced with a cut-out cock in the cross-over pipe between the brake pipe and the triple valve.

DEFECTS OF THE PLAIN TRIPLE.

Blows of the plain triple valve may result from a leaky slide valve, the slide valve being held off its seat by foreign matter, or a leak from passage *e* to passage *r*, past the cut-out cock, with the old plain triple.

To distinguish between a blow at the slide valve or the cut-out cock, a ten-pound reduction should be made. If the blow at the triple exhaust continues and the brake releases, it is the slide valve, but if the blow stops and the brake sets harder, and when the brake is released the blow starts again, the trouble is in the cut-out cock.

THE QUICK ACTION TRIPLE VALVE.

The quick action triple valve is located in the brake system as shown on Plate 2.

This valve receives its name from the three distinct operations it performs in response to variations of brake pipe and auxiliary reservoir pressure, which are: (1) it charges the auxiliary reservoir; (2) applies the brakes; (3) releases the brakes. The various positions of the working parts of the triple valve in accomplishing these results are shown on Plates 29, 30, 31 and 32. Plate 33 is a perspective view of the slide valve and its seat.

List of Parts. The various parts of the triple valve, as shown on Plate 29, are as follows:

- | | |
|----------------------------|---------------------------------------|
| 2. Triple Valve Body. | 13. Check Valve Case. |
| 3. Slide Valve. | 14. Check Valve Case Gasket. |
| 4. Main Piston. | 15. Check Valve. |
| 5. Piston Packing Ring. | 16. Strainer. |
| 6. Slide Valve Spring. | 19. Cylinder Cap. |
| 7. Graduating Valve. | 20. Graduating Stem Nut. |
| 8. Emergency Piston. | 21. Graduating Stem. |
| 9. Emergency Valve Seat. | 22. Graduating Spring. |
| 10. Emergency Valve. | 23. Cylinder Cap Gasket. |
| 11. Emergency Valve Rubber | 28. Emergency Valve Nut. |
| Seat. | <i>i</i> and <i>k</i> . Feed Grooves. |
| 12. Check Valve Spring. | |

Strainer 16 is designed to exclude foreign matter from the triple valve. Piston 4 operates in response to variations of brake pipe and auxiliary reservoir pressures, to open and close feed groove *i*, and controls the movement of the slide valve and the

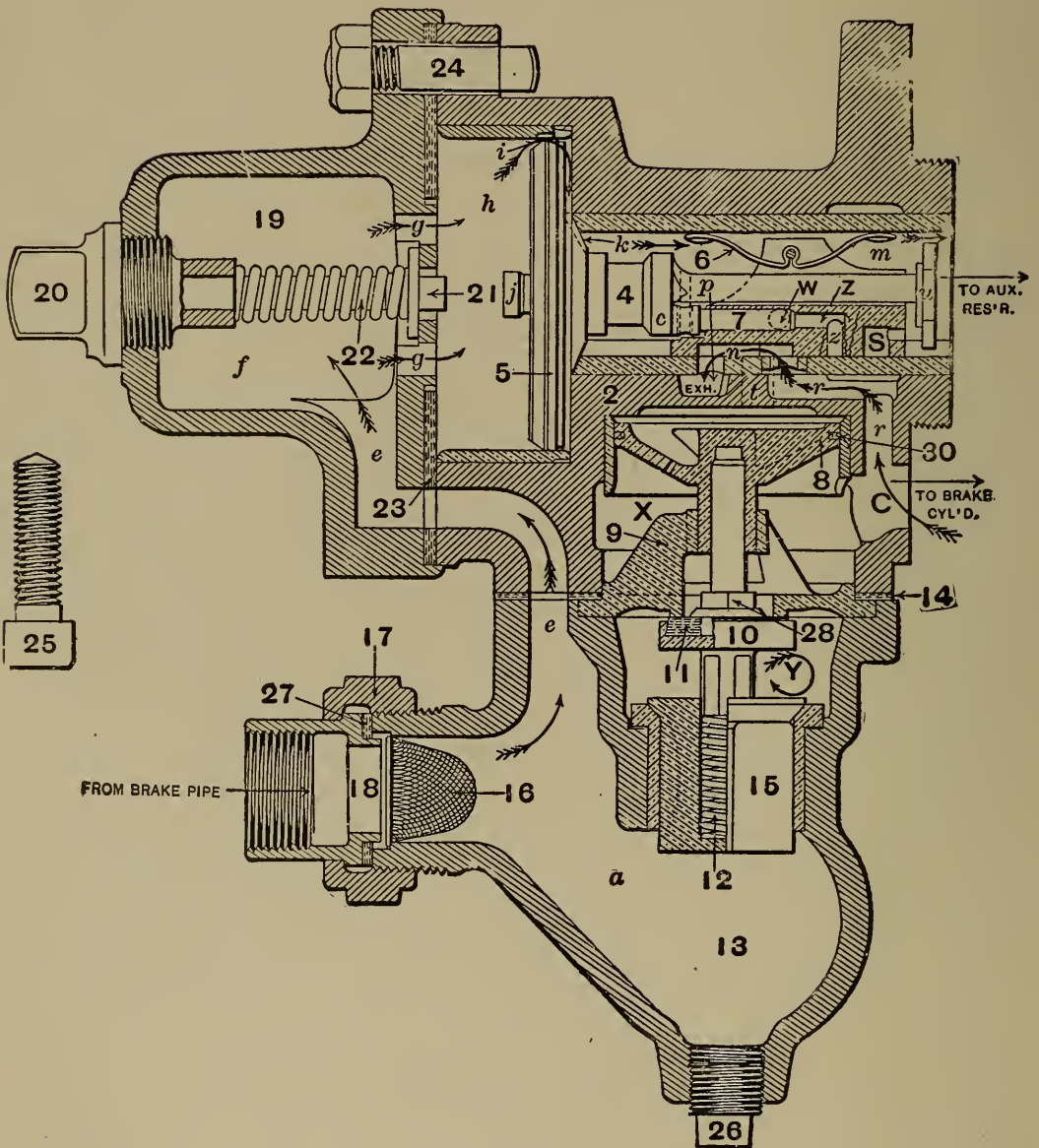


PLATE 29.

graduating valve. The latter is secured to the piston stem by a pin, shown by the dotted lines.

The graduating valve (in a service application), moved by the main piston, controls the flow of air from the auxiliary reservoir through ports *W* and *Z* of the slide valve.

The slide valve, moved by the main piston, controls communication between the brake cylinder and the atmosphere, between the auxiliary reservoir and the brake cylinder, and also between the auxiliary and the chamber above emergency piston 8.

Charging. Air from the brake pipe enters the triple valve at *a* (Plate 29) and flows through passages *e*, *f*, *g* and *h*, past the main piston, through feed grooves *i* in the bushing and *k* in the piston seat, and thence through chamber *m* to the auxiliary reservoir, as indicated. Air continues to flow from the brake pipe to the auxiliary reservoir until the pressures equalize, when the main piston is balanced.

The main piston constitutes a movable partition wall, separating the brake pipe and auxiliary reservoir pressures, and in studying the operation of the triple valve under various conditions, the first essential consideration is always as to which face of the main piston is exposed to the greatest pressure, as this determines the direction in which it will move. The usual brake pipe pressure is seventy pounds, acting upon both faces of the main piston when the brake pipe and auxiliary reservoirs are fully charged.

Service Application. To apply the brakes for a service stop, a gradual reduction of brake pipe pressure is necessary, and for the purpose of illustration the first reduction will be one of five pounds, thus leaving a pressure of sixty-five pounds to act upon the brake pipe face of the main piston, while the original seventy pounds still operates upon the auxiliary reservoir face. As a result of this reduction, the greater auxiliary reservoir pressure forces the main piston to the left. As the piston moves, it closes feed groove *i*, cutting off communication between the brake pipe and the auxiliary reservoir, and unseats graduating

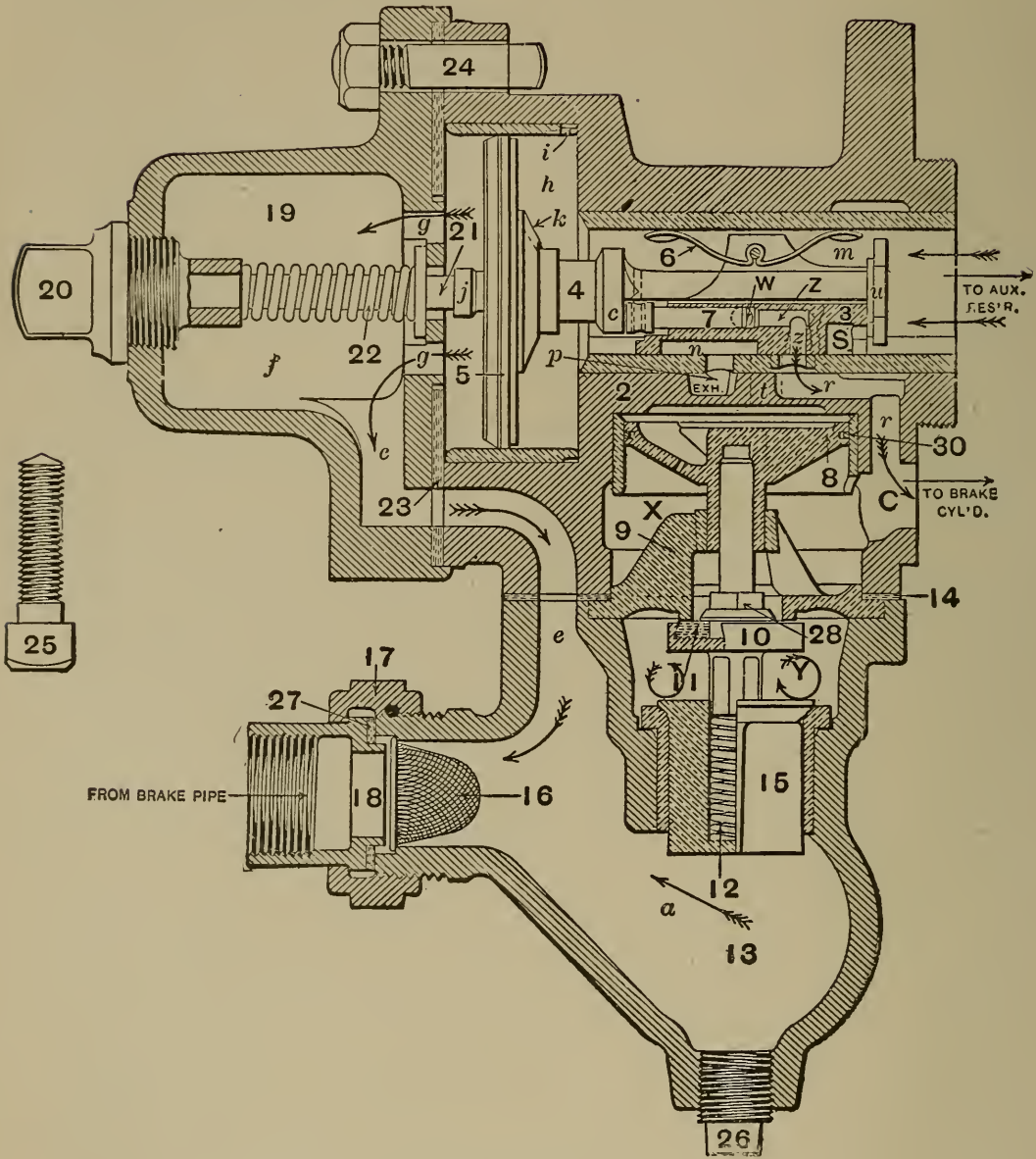


PLATE 30.

valve 7, establishing communication between transverse passage W and port Z of the slide valve. When the graduating valve has become unseated, the collar at the end of the piston stem engages the slide valve, which is then also moved to the left by the further movement of the piston, thereby cutting off communication between exhaust cavity *n* in the slide valve and passage *r* leading to the brake cylinder. The movement of the main piston to the left is arrested by contact of its stem *j* with graduating stem 21, which is held in position by graduating spring 22. In this position, port Z in the slide valve registers with port *r*, and auxiliary reservoir air flows through ports W and Z of the slide valve and passage *r* to the brake cylinder at C (Plate 30). When the auxiliary reservoir pressure has become slightly less than that (sixty-five pounds) upon the brake pipe face of the main piston, the greater brake pipe pressure forces the piston back sufficiently to seat the graduating valve as shown on Plate 31. This is known as "lap" position.

If it is afterwards desired to apply the brakes with greater force, a further brake pipe reduction is made, which again leaves the auxiliary reservoir pressure in excess of that in the brake pipe, which will force the main piston to the left and unseat graduating valve 7. A corresponding further reduction of auxiliary reservoir pressure results, through the discharge of air into the brake cylinder. Such brake pipe reductions may be repeated until the auxiliary reservoir and brake cylinder pressures are equal. The brakes are then fully applied and any further brake pipe reduction is a waste of air. A total reduction of about twenty pounds causes the brake pipe auxiliary reservoir and brake cylinder pressures to equalize.

Emergency Application. A gradual or service reduction of brake pipe pressure causes the main piston to move to the left until stem *j* encounters stem 21, when the tension of the graduating spring prevents a further movement, but a sudden brake pipe reduction causes the main piston to move out so quickly that graduating spring 22 cannot withstand the impact of stem *j*, and

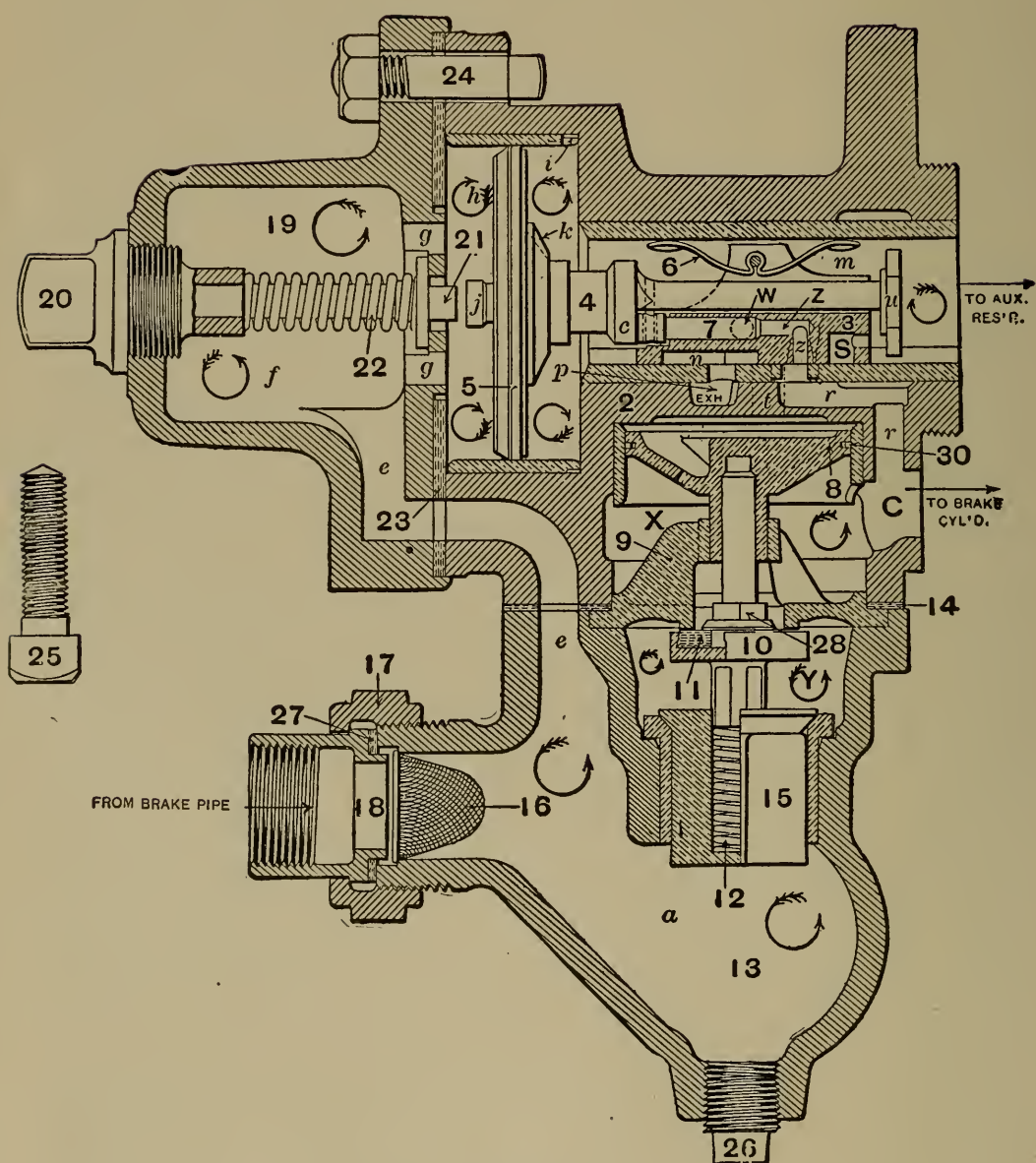


PLATE 31.

yields so that the piston moves to the position shown on Plate 32. In this position, a diagonal slot in the slide valve (Plate 33) uncovers port *t* (indicated by dotted lines just below the letter Z), which admits air from the slide valve chamber to the chamber above emergency piston 8. Piston 8 is thereby forced downward and unseats emergency valve 10, allowing the pressure in the small chamber Y, above check valve 15, to escape into the brake cylinder. The brake pipe pressure almost instantly raises the check valve, and the brake pipe air rushes through chambers *a* and Y into the brake cylinder at C. Air from the auxiliary reservoir simultaneously flows through port S of the slide valve and passage *r* into the brake cylinder, but port S being very small in comparison with the passageway through chambers *a*, Y and C, only a small amount of auxiliary reservoir air reaches the brake cylinder before the brake pipe and cylinder pressures are equalized, allowing the check valve to seat and prevent the air from escaping from the cylinder to the brake pipe. It thus may be seen that in an emergency application an increased brake cylinder pressure is secured through the presence of the air supplied by the brake pipe, in addition to that from the auxiliary reservoir, which is the only source of air pressure for the brake cylinder during a service application of the brakes.

The rapid discharge of air from the brake pipe into the brake cylinder, in addition to the sudden reduction made at the brake valve, causes a similar operation of the triple valve upon the next car. The operation of that triple valve similarly affects the next, and so on, serially, throughout the train.

Release. To release the brakes the engineman admits main reservoir pressure into the brake pipe, thus increasing the pressure upon the brake pipe face of the main piston until it becomes greater than that upon the auxiliary reservoir side, and forcing the piston to its normal or release position, shown on Plate 29. In this position the air in the brake cylinder is discharged through passage *r*, exhaust cavity *n* in the slide valve and passage *p* to the atmosphere, either directly or through the pressure retaining

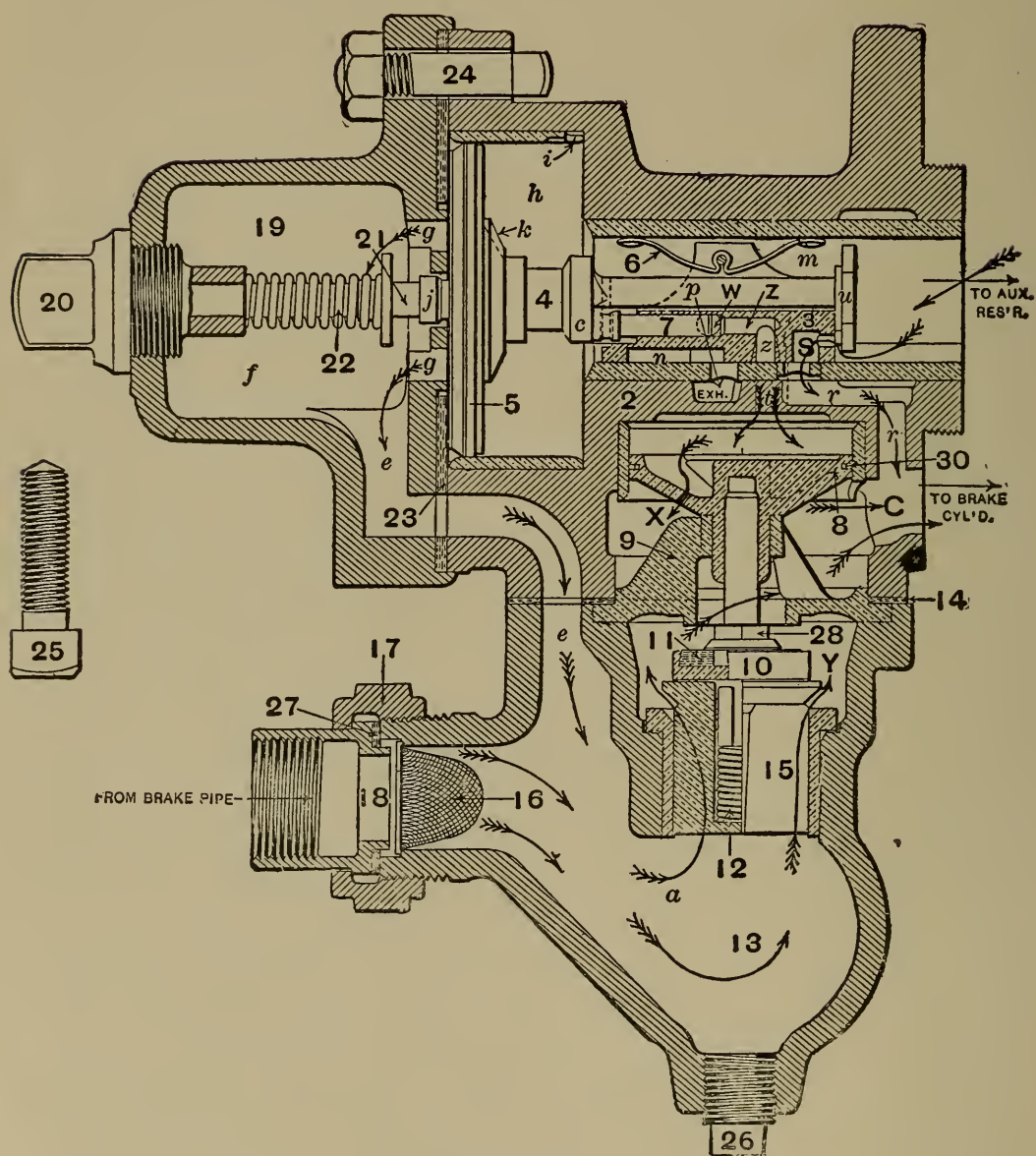


PLATE 32.

valve. Feed groove *i* being again uncovered, the auxiliary reservoir becomes recharged with air from the brake pipe.

Purposes of the Triple Piston, Slide and Graduating Valves.

The duty of the triple piston is to open and close the feed groove and to guide the movement of the slide valve and graduating valve, and also to form a dividing line between the auxiliary reservoir and brake pipe pressures.

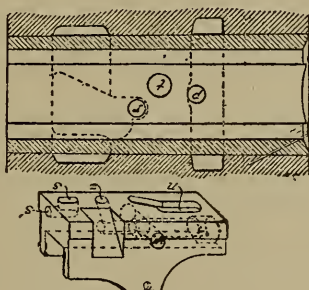


PLATE 33.

The purpose of the slide valve is to open and close communication between the brake cylinder and the atmosphere and to open and close communication between the auxiliary reservoir and the brake cylinder in conjunction with the graduating valve and the triple piston. It is also the duty of the slide valve in the quick action triple to open and close communication between the auxiliary reservoir and the emergency piston, and between the auxiliary reservoir and the brake cylinder in conjunction with the triple piston.

The duty of the graduating valve is to graduate the flow of air from the auxiliary reservoir to the brake cylinder.

DEFECTS OF THE QUICK ACTION TRIPLE VALVE.

Defects that will cause a blow at the triple exhaust are, the slide valve held off its seat by dirt, the slide valve seat cut, a defective gasket 15 between the auxiliary and the triple valve, defective gasket between the brake cylinder head and the triple

valve, auxiliary tube *b* in freight equipment becoming cracked, defective check case gasket 14, or a defective rubber seated valve 10.

A slide valve leak, defective gasket between the triple and auxiliary, cracked auxiliary tube *b*, or leaky gasket between the triple and brake cylinder would have the effect of reducing the pressure in the auxiliary reservoir and releasing the brake, while a leaky gasket 14 or a leak in the rubber seated valve 10 would reduce the brake pipe pressure and tend to set the brake with greater force.

Distinguishing Leaks. To distinguish between the various blows at the triple exhaust, a ten-pound reduction should be made. If the blow stops, the brake sets harder, then releases, and the blow then starts again at the triple exhaust, the trouble is due to a leak between the triple and auxiliary or between the triple and brake cylinder, or a cracked auxiliary tube *b*. But if, after making the reduction, the blow continues and the brake releases, it would be due to a defective slide valve, while if the blow stopped at the triple exhaust, the brake set harder and did not release, it would indicate a leak at gasket 14 or at the rubber seated valve.

A leaky bleeder of the auxiliary reservoir, a leak in the pipe connection leading from the triple valve to the auxiliary reservoir or the pipe connection leading from the triple valve to the brake cylinder, the packing leather in the brake cylinder becoming worn, the piston not covering the leakage grooves, or a leak between the brake cylinder head and the cylinder, will also release the brake.

The effect produced by a leak at the graduating valve is uncertain and would depend on the conditions connected with it. When the brake is applied the triple valve assumes lap position. If the graduating valve leaks, the auxiliary pressure gradually reduces and the brake pipe pressure forces the piston and slide valve back until the blank on the face of the slide valve between ports *Z* and *u* is in front of port *r*. This blank space is only a trifle wider than port *r*. If the valve is in good condition

and works smoothly the brake should not release, but if it works hard it is likely to jump when it moves, thus opening the exhaust port and releasing the brake.

NEW TYPES OF WESTINGHOUSE TRIPLE VALVES.

The greatly changed conditions in the operation of railway trains during the past few years, incident to the employment of locomotives capable of handling long trains of freight cars, as well as the large number of air brakes in such trains, also the air brake requirements in connection with passenger trains, have created conditions which the well-known types of triple valves have in many instances proved unable to meet.

By reference to cuts showing the arrangement of the ports in the slide valve, graduating valve and slide valve bushing of this new type of triple (Plate 35), it will be noted that the general arrangement of ports is along each side of a longitudinal center line, rendering it somewhat difficult to follow the course of air through them with sectional views in which the actual arrangement of ports is shown. Diagrammatic cuts are used, therefore, for illustrating the valves in their several positions, all ports and passages having been so rearranged as to place them on a single plane. In preparing these cuts the actual proportion and mechanical construction of the valves have been sacrificed for the purpose of making them as easily understood as possible.

In this new valve, the triple piston, slide valve and graduating valve are the same in their relation to each other as in the older well-known types of triples, the graduating valve, however, being of the sliding type and located on top of the slide valve. The triple piston constitutes a movable partition separating brake pipe and auxiliary reservoir pressure. To apply or release the brake, air pressure is reduced or increased until a sufficient differential is created on opposite sides of the piston to overcome the friction of the piston packing ring and slide valve.

THE TYPE "K" TRIPLE VALVE.

The new quick action freight triple valve, designated as type "K," facilitates train movements, increases the factor of safety in handling trains, and reduces damage to lading and equipment in so far as they are affected by air brake operation.

Improvements Over the Old Type Triple. The old type "H" quick action freight triple valve was designed to meet the requirements of the time when fifty-car trains, thirty-ton capacity cars, and moderate speeds were maximum conditions. But the increased train lengths, higher speeds and greater car capacities of the present age, have demanded certain modifications to meet these, and anticipate future requirements.

The "K" triple valve embodies every feature of the old type and, in addition, three new ones called the Quick Service, Retarded Release and Uniform Recharge. It not only works in harmony with the old valve, but greatly improves the action of the latter when they are mixed in the same train. They have many parts in common, are interchangeable, and the old type quick action triple can be converted into the new, without the loss of many parts.

Quick Service. The quick service feature, which produces a quick serial operation of the brakes in service application, has been obtained by utilizing the well-known principle of quick action in emergency applications, by which each triple valve augments the brake pipe reduction by discharging brake pipe air into its brake cylinder. The essential difference is that in emergency the maximum braking power is always obtained with both the old and new types of valves, while with the new valve, the power of its quick service application is always under complete control and is governed by the reduction made at the brake valve. The result is that the quick service feature insures the prompt and reliable response of every brake, eliminates the undesirable use of emergency applications where an unforeseen danger ahead, or the need of making accurate stops frequently, necessitates such applications with the old standard freight brake

equipment, reduces the possible loss of air due to its flowing back through the feed grooves from the auxiliary reservoir to the brake pipe, or by the leakage grooves in the cylinders, and gives a more uniform application of the brakes throughout the train.

Release Feature. The retarded release feature, which insures practically a uniform release of all brakes, has been effected by automatically restricting the exhaust of air from the brake cylinders at the head end of the train, and allowing all others to release freely. To obtain this result requires merely the usual correct method of operating the brake valve, the retarded release being due to the quick and considerable rise in brake pipe pressure which occurs in the brake pipe for about twenty-five or thirty cars from the locomotive in long trains. This is possible, for the reason that the frictional resistance to the flow of air through the brake pipe prevents the building up of brake pipe pressure in the balance of the train faster than it can flow into the auxiliary reservoirs.

Recharging. The uniform recharge of the auxiliary reservoirs throughout the train is obtained by the fact that when the triple valve is in retarded release position, the charging ports between the brake pipe and the auxiliary reservoir are automatically restricted. As long as the release of brake cylinder exhaust is retarded, the recharge is restricted, and since the one feature depends upon the other, the restricted recharge operates only on the first twenty-five or thirty cars back of the locomotive, the remaining brakes recharging normally, thus insuring practically a simultaneous recharge of all brakes in the train.

This feature not only avoids the overcharge of the auxiliary reservoirs on the front cars, and the subsequent undesired reapplication of their brakes, but, by drawing less air from the brake pipe, permits the increase in brake pipe pressure to travel more rapidly to the rear for the purpose of releasing and recharging those brakes.

Sizes of Valves. The new valve is at present manufactured in two sizes, the K-1 for use with eight-inch freight car brake

cylinders, corresponding with the H-1, and the K-2 for use with ten-inch freight car brake cylinders, corresponding with the H-2. The K-1 will bolt to the same reservoir as the H-1, and the K-2 to the same as the H-2. Each valve is marked with its designation on the side of the valve body, and the K-2 may be distinguished from the K-1 by the fact that it has three, instead of two, bolt holes in the reservoir flange. Also, in order to distinguish the type "K" valves from the old standard type, their exterior being similar when they are attached to the auxiliary reservoir, a lug is cast on top of the valve body. This enables anyone to distinguish them at once.

List of Parts. Plate 34 shows a vertical cross section of this valve, and the names of the various parts, as follows:

- | | |
|-------------------------------------|-----------------------------------|
| 2. Valve Body. | 20. Graduating Stem Nut. |
| 3. Slide Valve. | 21. Graduating Stem. |
| 4. Piston. | 22. Graduating Spring. |
| 5. Piston Packing Ring. | 23. Cylinder Cap Gasket. |
| 6. Slide Valve Spring. | 24. Bolt and Nut. |
| 7. Graduating Valve. | 25. Triple Valve Cap Screw. |
| 8. Emergency Piston. | 26. Drain Plug. |
| 9. Emergency Valve Seat. | 27. Union Gasket. |
| 10. Emergency Valve. | 28. Emergency Valve Nut. |
| 11. Emergency Valve Rubber
Seat. | 29. Retarding Device
Bracket. |
| 12. Check Valve Spring. | 30. Retarding Device Screw. |
| 13. Check Valve Case. | 31. Retarding Device Stem. |
| 14. Check Valve Case Gasket | 32. Retarding Device
Washer. |
| 15. Check Valve. | 33. Retarding Device Spring. |
| 16. Air Strainer. | 34. Retarding Device Stem
Pin. |
| 17. Union Nut. | 35. Graduating Valve Spring. |
| 18. Union Swivel. | |
| 19. Cylinder Cap. | |

Positions of Ports, Passages and Cavities. Plate 35 shows the relative positions of the ports and cavities in the slide valve, graduating valve and slide valve seat. As it is difficult to show

all of these in a single section, diagrammatic cuts of the valve are used, showing it in each of its principal positions, all ports and passages having been so arranged as to place them on one plane. In preparing these cuts, the actual proportion and mechanical construction of the valve have been disregarded for the purpose of making the connections of ports, and the operation of the valve more easily understood.

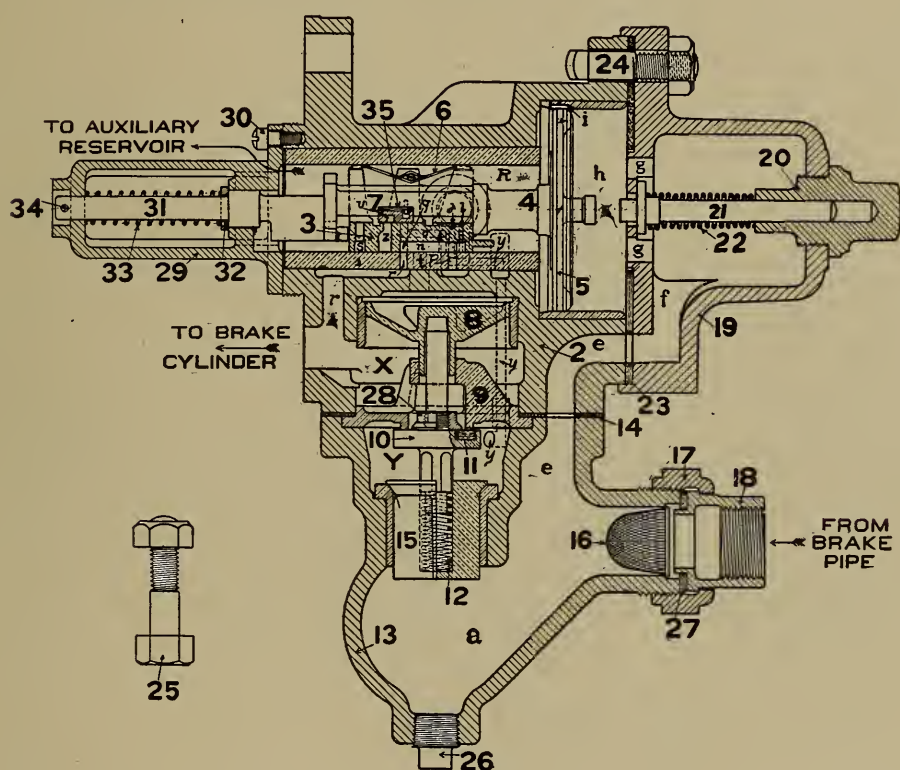


PLATE 34.

Retarding Device. Referring to Plate 34, the branch from the brake pipe connects at union swivel 18. The retarding device bracket 29 projects into the auxiliary reservoir, and by its construction free communication exists between the auxiliary reservoir and chamber R, in which slide valve 3 and graduating valve 7 operate. The retarding device stem 31, through its extension into chamber R and the action of its spring 33, forms the stop against which the stem of piston 4 strikes when it moves to re-

lease position, from right to left in the cut, it being shown in full release position.

Openings. The opening marked "To Brake Cylinder" comes opposite one end of the tube which leads through the auxiliary reservoir to the brake cylinder, when the valve is bolted in place on the end of the auxiliary reservoir. This opening in the triple valve leads to chamber X over the emergency valve 10 and under emergency piston 8. It also leads through port *r* to the seat under slide valve 3. The emergency piston 8 and the parts below it are the same as in the older quick action freight triple valve. Port *y* (shown by dotted lines) connects chamber Y, between check valve 15 and emergency valve 10, with port *y* in the valve seat (Plate 34).

(NOTE: Dotted lines are used to indicate a port or part which is hidden by other parts of the mechanism, and would not be seen when looking at the device from the point of view taken. Some examples of this are shown on Plate 36).

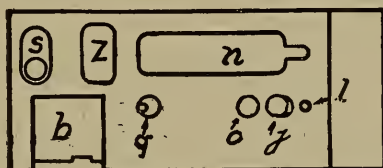
Ports. Port *t* connects the slide valve seat with the chamber above emergency piston 8. Port *p* is the exhaust port to the atmosphere. Port *j* in the slide valve begins at the face as shown by the top view (Plate 36), and passes around other ports in the valve to a smaller opening in the top. (Port *j* does not exist in the K-1 triple valve, as will be explained later). Port *o* is similarly arranged, except that the openings in the top and bottom are alike in size. Port *q* runs directly through the slide valve, but is smaller at the top than at the face of the valve, and the smaller part is out of center with the larger part. Ports *s* and *z* run through the valve and connect with cavities in the face; port *z* also has a cavity at the top.

Cavities. The face view of the graduating valve shows that it has a small cavity *v*. This valve is of the slide valve type, and it seats on top of the slide valve, where it controls the upper ends of ports *z*, *q*, *o* and *j*. The purpose of cavity *v* is to connect the upper ends of ports *o* and *q* in a service application, which will be explained in detail later.

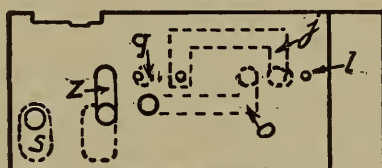


FACE VIEW

GRADUATING VALVE .

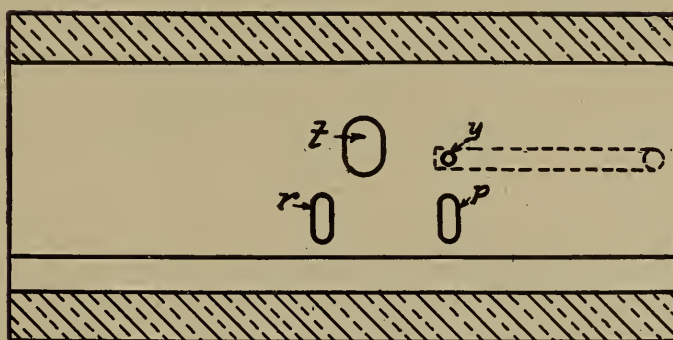


FACE VIEW



TOP VIEW

SLIDE VALVE.



SLIDE VALVE BUSH.

As shown by the face view of slide valve, *n* is a long cavity, having a narrow extension at the right hand end. This cavity connects the ports through which the air escapes from the brake cylinder in releasing. Port *b* is cut diagonally from the face until it just cuts into the edge, at the top of the slide valve. It admits auxiliary reservoir pressure to port *t* in an emergency application.

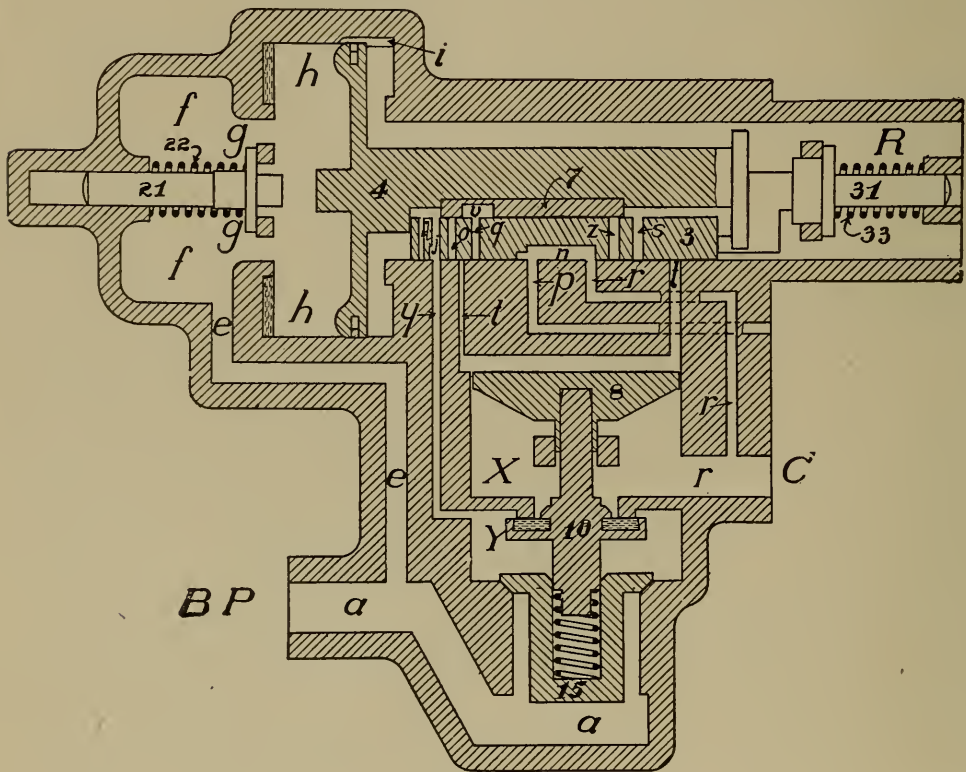


PLATE 36.

With this explanation and by occasional reference from the diagrammatic views to those on Plate 34, the same ports being lettered alike, a clear understanding will be obtained of both the operation and actual arrangement of the ports of the triple valve.

Full Release and Charging Position. Plate 36 is a diagrammatic view of the triple valve in this position. Air from the brake pipe flows through passage *a* to *e* and cylinder cap *f*, and ports *g* to chamber *h*; thence through feed groove *i*, now open, to cham-

ber R above the slide valve, which is always in free communication with the auxiliary reservoir. The feed groove is of the same dimension as that of the old standard H-1 triple valve, which is designed to charge the auxiliary reservoir of an eight-inch brake cylinder properly, and prevent any appreciable amount of air from feeding back into the brake pipe from the auxiliary reservoir during an application. For this reason, the feed groove of the K-2 triple valve is made the same size as the K-1, so that it is necessary in the K-2 triple to increase the charging port area, through which the air can feed into the auxiliary reservoir, sufficiently to enable it to handle the greater volume of the auxiliary reservoir of a ten-inch brake cylinder. In order to do this, the small port *j* is added to the slide valve of the K-2 triple valve only; this port registers with port *y* in the slide valve seat, when in full release position. Air then passes from chamber Y, through ports *y* and *j*, to chamber R and the auxiliary reservoir. Brake pipe air in *a* raises check valve 15 and supplies chamber Y with air as fast as it is required. Port *j* is so proportioned that the rate of charging the auxiliary reservoir of a ten-inch brake cylinder is made practically the same as that of the eight-inch, which in full release is fed through the feed groove *i* only.

In the following description the K-2 triple valve only is referred to; the operation of the K-1 is exactly the same except for the absence of port *j*.

Air flows from the brake pipe to the auxiliary reservoir until their pressures become equal, when the latter is then fully charged.

Quick Service Application. To make a service application of the brakes, air pressure is gradually reduced in the brake pipe, and thereby in chamber *h*. As soon as the remaining pressure in the auxiliary reservoir and chamber R becomes enough greater than that in chamber *h* to overcome the friction of the piston 4 and graduating valve 7, these two move to the left until the shoulder on the end of the piston stem strikes against the right-hand end of the slide valve, when it also is moved to the left until the

piston strikes the graduating stem 21, which is held in its place by the compression of graduating spring 22. The parts of the valve are then in the position shown on Plate 37. The first movement of the graduating valve closes the feed groove *i*, preventing the air from feeding back into the brake pipe from the auxiliary reservoir, and also opens the upper end of port *z* in the

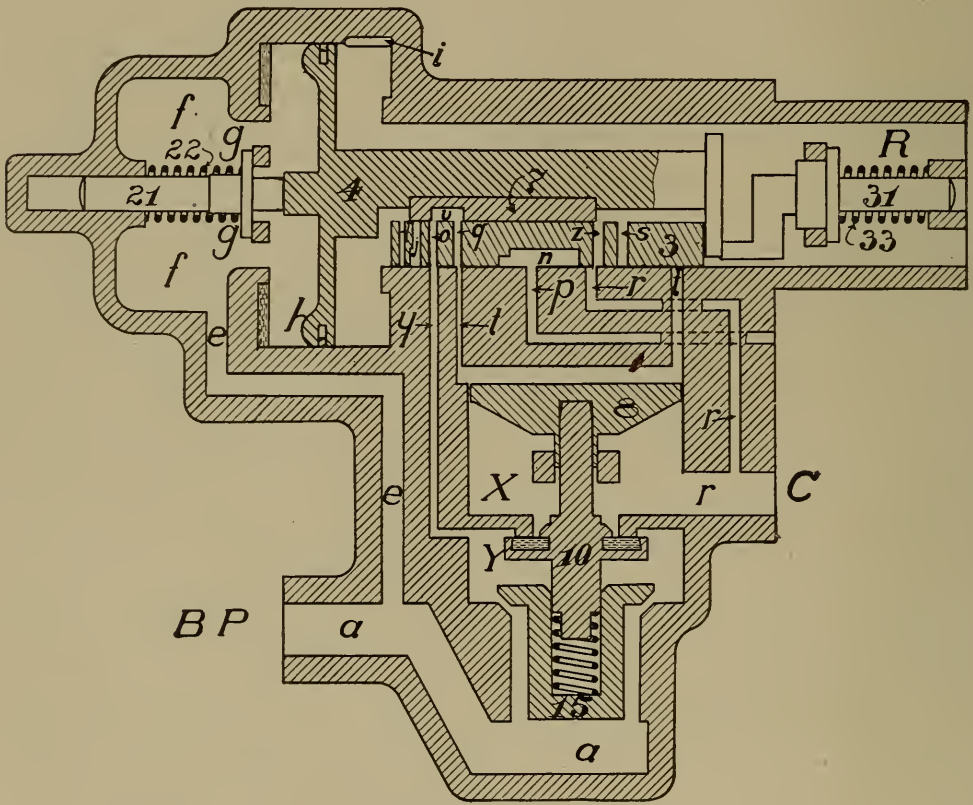


PLATE 37.

slide valve, while the movement of the latter closes the connection between port *r* and the exhaust port *p*, and brings port *z* into partial registration with port *r*, in the slide valve seat. Auxiliary reservoir pressure then flows through port *z* in the slide valve and port *r* in the seat to the brake cylinder.

At the same time the first movement of the graduating valve connected the two ports *o* and *q* in the slide valve, by the cavity *v*

in the graduating valve, and the movement of the slide valve brought port *o* to register with port *y* in the slide valve seat, and port *q* with port *t*. Consequently, the air pressure in chamber Y flows through ports *y*, *o*, *v*, *q* and *t*, thence around the emergency piston 8, which fits loosely in its cylinder, to chamber X and the brake cylinder. When the pressure in chamber Y has reduced below the brake pipe pressure remaining in *a*, the check valve raises and allows the brake pipe air to flow by the check valve and through the ports above mentioned to the brake cylinders. The size of these ports is so proportioned that the flow of air from the brake pipe to the top of emergency piston 8 is not sufficient to force the latter downward and thus cause an emergency application, but at the same time takes considerable air from the brake pipe, thus increasing the rapidity with which the brake pipe reduction travels through the train.

Advantages of the New Type Triple Valve in Quick Service Application. With the old style quick action triple valve in service application, all of the brake pipe reduction is made at the brake valve, and the resulting drop in pressure passes back through the train at a rate depending on its length, size of brake pipe, number of bends, corners, etc., which cause friction and resistance. A much heavier application of the head than of the rear brakes is also caused at the beginning of the application, thereby running the slack in, which is liable at low speeds to be followed by the slack running out suddenly when the rear brakes do apply, causing loss of time and difficulty in making quick slow-downs and accurate stops, and, with very long trains, results in such serious losses through leakage grooves and feed grooves as to lose a portion of the braking power and even prevent some brakes from applying. With this new triple valve, only a small part of the reduction is made at the brake valve while each triple acts momentarily as a brake valve to increase the reduction under each car, thereby rendering the resistance and friction in the brake pipe of much less effect, and hastening the application throughout the train. This is called the "Quick Service" feature, and by

means of it the rapidity of a full service application on a fifty-car train is increased about fifty per cent. The rapid reduction of brake pipe pressure moves the main piston 4 quickly to the service position and cuts off any flow back from the auxiliary reservoir through the feed groove to the brake pipe; it rapidly drives the brake cylinder piston beyond the leakage groove and prevents loss of air through it, and yet permits the applying of brakes with as moderate a brake force as desired. It also greatly reduces the brake pipe reduction necessary at the brake valve for a certain brake cylinder pressure, due to the fact (1) that part of the reduction takes place at each triple valve, and (2) that the air taken from the brake pipe into the brake cylinder gives a little higher pressure than if the auxiliary reservoir pressure alone were admitted, thus requiring a smaller brake pipe reduction for the same cylinder pressure.

Full Service Position. With short trains, the brake pipe volume, being comparatively small, will reduce more rapidly for a certain reduction at the brake valve than with long trains. Under such circumstances the added reduction at each triple valve by the quick service feature might bring about so rapid a brake pipe reduction as to cause quick action and an emergency application, when only a light application was intended. But this is automatically prevented by the triple valve itself. From Plate 37 it will be noted that in the quick service position, port *z* in the slide valve and port *r* in the seat do not fully register. Nevertheless, the opening is sufficient to allow the air to flow from the auxiliary reservoir to the brake cylinder with sufficient rapidity to reduce the pressure in the auxiliary reservoir as fast as the pressure is reducing in the brake pipe, when the train is of considerable length. But if the brake pipe reduction is more rapid than that of the auxiliary, the difference in pressures on the two sides of piston 4 soon becomes sufficient to compress the graduating spring slightly, and move the slide valve to the position shown on Plate 40. In this position, quick service port *y* is closed so that no air flows from the brake pipe to the brake cylinder.

The brake pipe reduction being sufficiently rapid, there is no need of the additional quick service reduction, so the triple valve cuts it out. Also ports *z* and *r* are fully open, and allow the auxiliary reservoir pressure to reduce more rapidly, so as to keep pace with the more rapid brake pipe reduction.

Lap Position. When the brake pipe reduction ceases, air continues to flow from the auxiliary reservoir through ports *z*

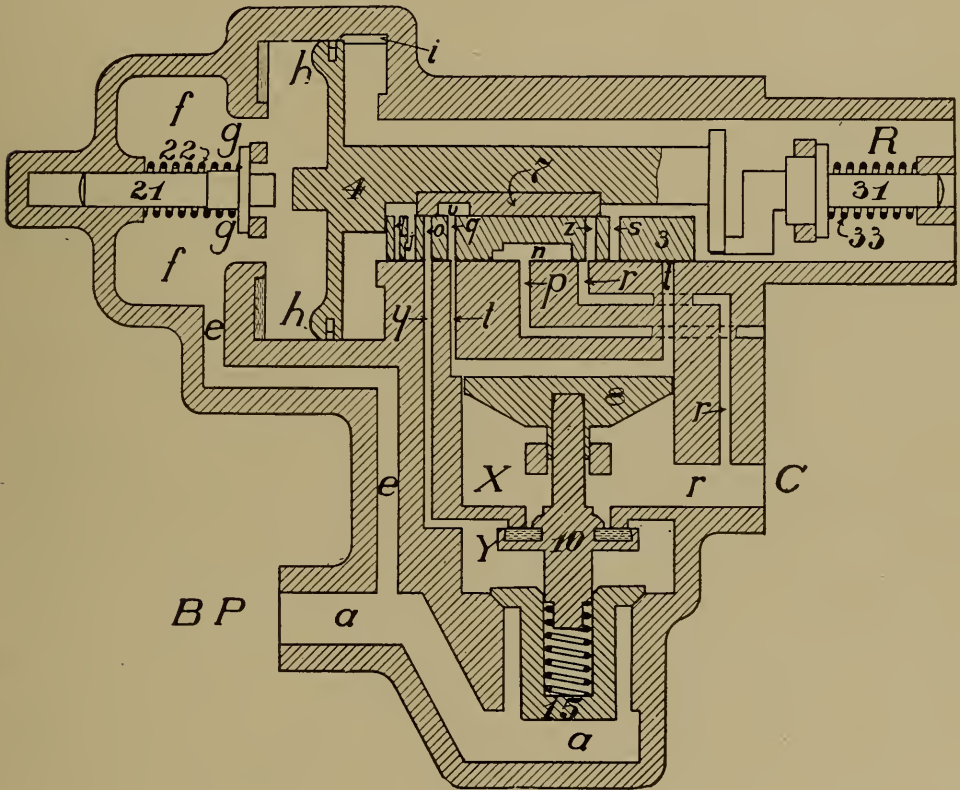


PLATE 38.

and *r* to the brake cylinder, until the pressure in chamber *R* becomes less than that of the brake pipe to cause piston 4 and graduating valve 7 to move to the right until the shoulder on the piston stem strikes the left-hand end of slide valve 3. As the friction of piston and graduating valve is much less than that of the slide valve, the difference in pressure which will move the piston and the graduating valve will not be sufficient to move all

three; consequently the piston stops in the position shown on Plate 38. This movement has caused the graduating valve to close port *z*, thus cutting off any further flow of air from the auxiliary reservoir to the brake cylinder. Consequently no further change in air pressure can occur, and this position is called "lap" because all ports are lapped; that is, closed.

If it is desired to make a heavier application a further reduction of the brake pipe pressure is made and the operation described above repeated, until the auxiliary reservoir and brake cylinder pressures become equal, after which any further brake pipe reduction is only a waste of air. About twenty pounds brake pipe reduction will give this equalization.

Retarded Release and Charging Position. The "K" triple valve has two release positions, full release and retarded release. Which one of its ports will move when the train brakes are released depends upon how the brake pipe pressure is increased. If slowly it will be full release, and if quickly and considerably it will be retarded release.

It is well known that in freight train service, when the engineer releases the brakes, the rapidity with which the brake pipe pressure increases on any car depends on the position of the car in the train. Those cars towards the front receiving the air first will have their brake pipe pressure raised more rapidly than those in the rear with the old standard apparatus. This is due to two things, (1) the friction in the brake pipe; (2) the fact that the auxiliary reservoirs in the front at once begin to recharge, thus tending to reduce the pressure head by absorbing a quantity of air and holding back the flow from the front to the rear of the train. The retarded release feature of this new triple valve overcomes the second point mentioned, taking advantage of the first while doing so. The friction of the brake pipe causes the pressure in chamber *h* to build up more rapidly on triple valves toward the front than those in the rear. As soon as its pressure is enough greater than auxiliary reservoir pressure, remaining in chamber *R* after the application above described, to overcome the

friction of the piston, graduating valve and slide valve, all three are moved toward the right until the piston stem strikes the retarding device stem 31. The latter is held in position by the retarding device spring 33. If the rate of increase of the brake pipe pressure is small, as, for example, when the car is near the rear of the train, the triple valve parts will remain in this position, as shown on Plate 36, the brakes will release and the auxiliary

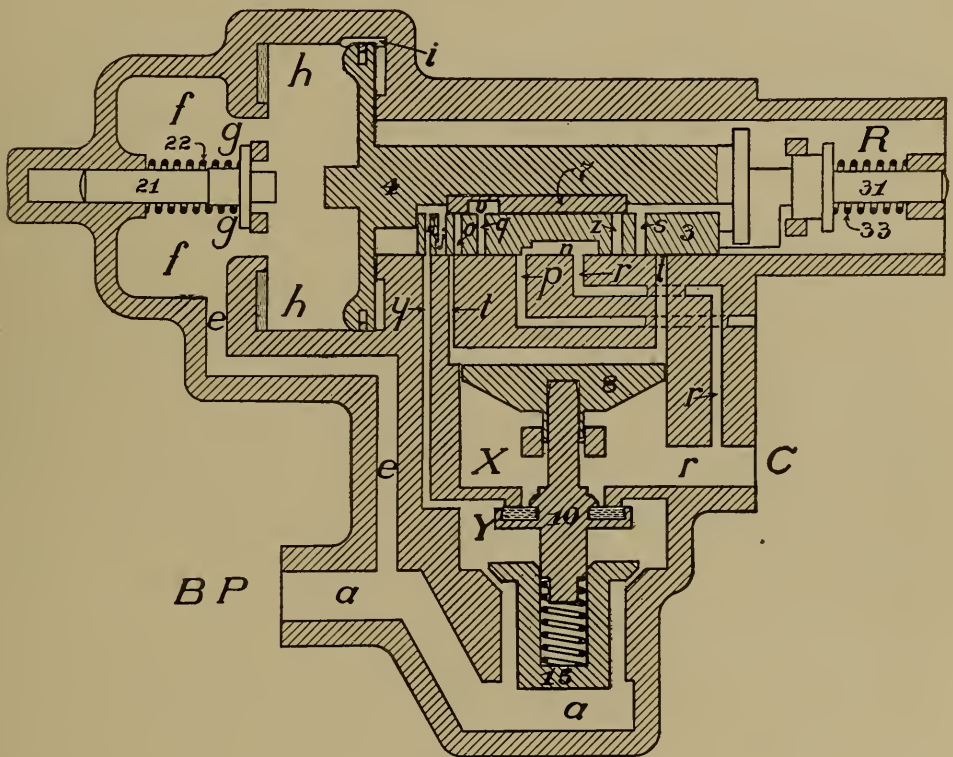


PLATE 39.

reservoirs recharge as described under "Full Release and Charging." If, however, the triple valve is near the head of the train, and the brake pipe pressure builds up more rapidly than the auxiliary reservoir can recharge, the excessive pressure in chamber *h* will cause the piston to compress retarding device spring 33 and move the triple valve parts to the position shown on Plate 39.

Exhaust cavity *n* in the slide valve 3 connects port *r* leading to the brake cylinder, with port *p* to the atmosphere, and the brake will release; but as the small extension of cavity *n* (Plate 39) is over port *p*, discharge of air from the brake cylinder to the atmosphere is quite slow. In this way the brakes on the front end of the train require a longer time to release than those on the rear. This feature is called the "Retarded Release," and although the triple valves near the locomotive commence to release before those in the rear, as is the case with the old type triple valve, yet the exhaust of brake cylinder pressure in retarded release position is sufficiently slow to allow the rear brakes to release first. This permits of releasing the brakes on very long trains at low speeds without danger of a severe shock or break-in-two.

At the same time, the back of the piston is in contact with the end of the slide valve bushing and, as these two surfaces are ground to an accurate fit, their contact effectually cuts off communication between chambers *h* and R through feed groove *i*, preventing air from feeding through from the brake pipe to the auxiliary reservoir by this path. Also port *l* in the slide valve registers with port *y* in the slide valve seat, and pressure in chamber Y can flow through ports *y* and *l* to chamber R and the auxiliary reservoir. Chamber Y is supplied with air under these circumstances by the check valve 15 raising and allowing brake pipe air to flow past it. The area of port *l* is about half that of feed groove *i*, so that the rate at which the auxiliary reservoir will recharge is much less than when the triple valve is in full release position.

As the auxiliary reservoir pressure rises, and the pressures on the two sides of piston 4 become nearly equal, retarding device spring 31 forces the piston, slide valve, graduating valve and retarding device stem back to the full release position shown on Plate 36, when the remainder of the release and recharging will take place as previously described under "Full Release and Charging."

These features of the new valve are always available, even

when mixed in trains with the old standard, the beneficial results being in proportion to the number of new valves present.

Emergency Position. Emergency position is the same with the "K" triple valve as with the old type. Quick action is caused by a sudden and considerable reduction in brake pipe pressure, no matter how caused. This fall in brake pipe pressure causes the difference in pressures on the two sides of piston 4 to increase

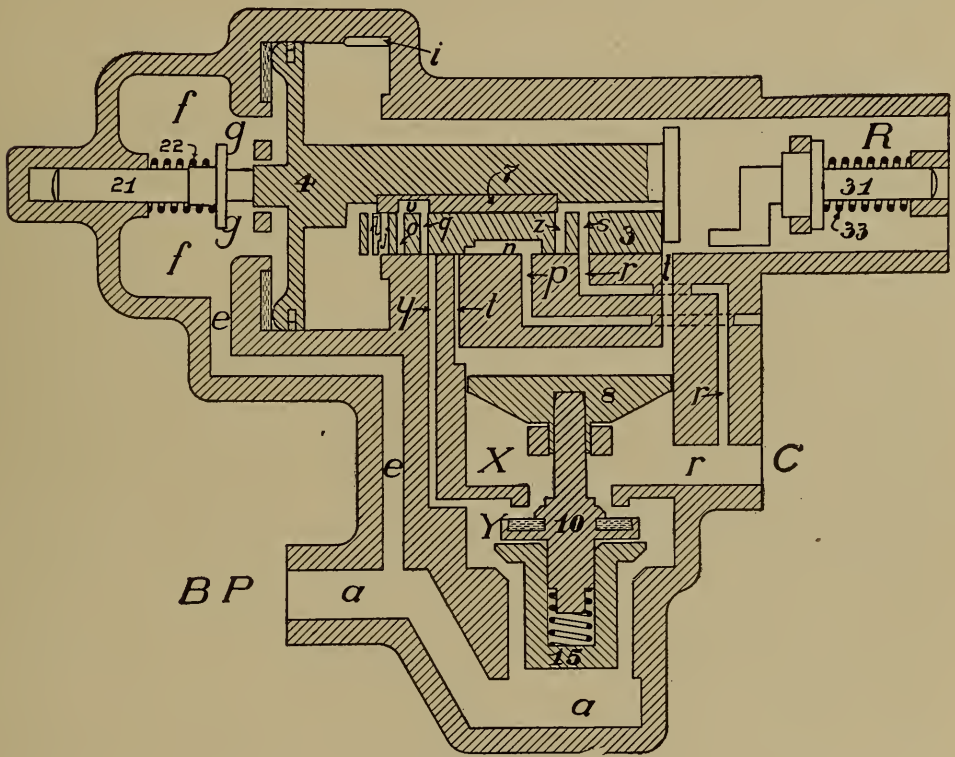


PLATE 40.

very rapidly, so that the friction of the piston, slide valve and graduating valve is quickly and easily overcome, and they move to the left with such force that when the piston strikes the graduating stem it compresses graduating spring 22, forcing back the stem and spring, until the piston seats firmly against gasket 23, as shown on Plate 40. The movement of the slide valve opens port *t* in the slide valve seat, and allows auxiliary reservoir pressure to flow to the top of emergency piston 8, forcing the latter

downward and opening emergency valve 10. The pressure in chamber Y, being instantly relieved, allows brake pipe air to raise the check valve 15 and flow rapidly through chambers Y and X to the brake cylinder, until brake cylinder and brake pipe pressures equalize, when both check valve and emergency valve are forced to their seats by the spring in the former, preventing the pressure in the cylinders from escaping back into the brake pipe. At the same time port *s* in the slide valve registers with port *r* in the slide valve seat, and allows auxiliary reservoir pressure to flow to the brake cylinder. But the size of ports *s* and *r* is such that very little air gets through them before the brake pipe pressure has stopped venting into the brake cylinder.

This sudden discharge of brake pipe air into the brake cylinder has the same effect on the next triple valve as would be caused by a similar discharge of brake pipe air to the atmosphere. In this way each triple valve applies the next, thus giving the quick and full application through the greater amount of brake pipe air admitted to the brake cylinders. The rapidity with which the brakes apply throughout the train is so much increased that in a fifty-car train it requires less than three seconds; the brake cylinder pressure is also increased approximately twenty per cent.

The release after an emergency is effected in exactly the same manner as after a service application, but requires a longer time, owing to the higher brake cylinder pressures and lower brake pipe pressures.

To change a standard type "H" triple valve to the type "K," it is necessary to add the retarded release feature and to make the necessary changes in the controlling valves, body and check valve case.

THE WESTINGHOUSE TRAIN AIR SIGNAL SYSTEM.

Plate 41 shows the general arrangement of the parts of the train air signal system upon a locomotive, tender and car. This plate is not intended to show the exact location of the parts, but is an illustration of the general arrangement only.

PRESSURE REDUCING VALVE.

The pressure reducing valve is a valve connected to the main reservoir and used for supplying air to the signal system at a lower pressure than that in the main reservoir. The best results are obtained by using a pressure of 40 pounds, which is considered standard.

A short, quick exhaust, or reduction, is necessary to cause the whistle to sound properly. The signal valve operates on the same principle as the quick action part of the triple valve, which is thrown into operation by a short, quick exhaust, while a longer, though a more gradual, reduction would cause only a service application. With the signal apparatus, a short, quick reduction will cause the whistle to respond, while a long, gradual reduction will not cause it to sound.

When a slow, gradual reduction of the signal line pressure is made, instead of reducing the pressure in the signal line below that in the chamber under the diaphragm, the pressure feeds from this chamber back into the signal line, thus removing the power that should operate the diaphragm or signal valve. This action is also assisted by the pressure reducing valve, which is open and feeding into the signal line at all times when the pressure is reduced below 40 pounds.

Fig. 4, Plate 42, is a vertical sectional view of the improved signal reducing valve. The operative parts of the reducing valve are Supply Valve 4, Supply Valve Spring 6, Reducing Valve Piston 7, Piston Rod 10, Diaphragm 11, and Regulating Spring 13.

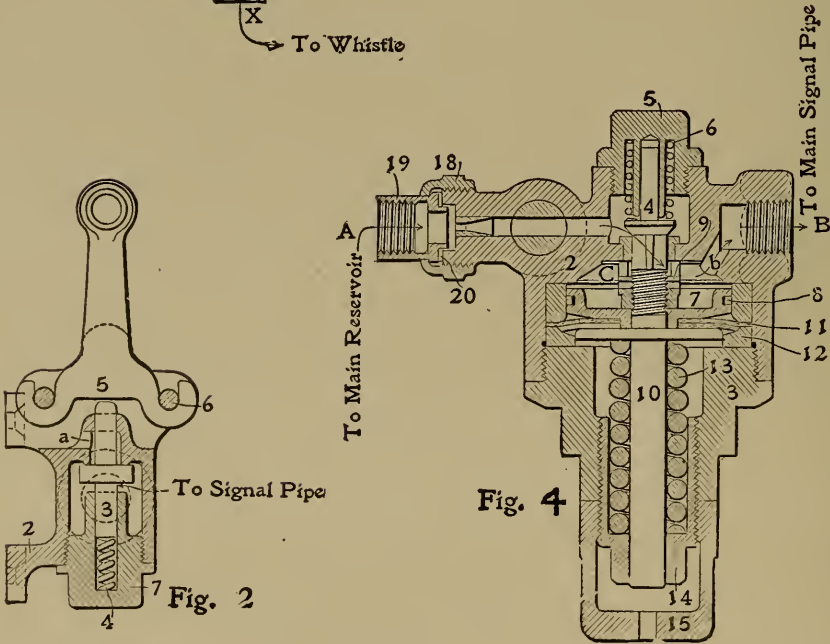
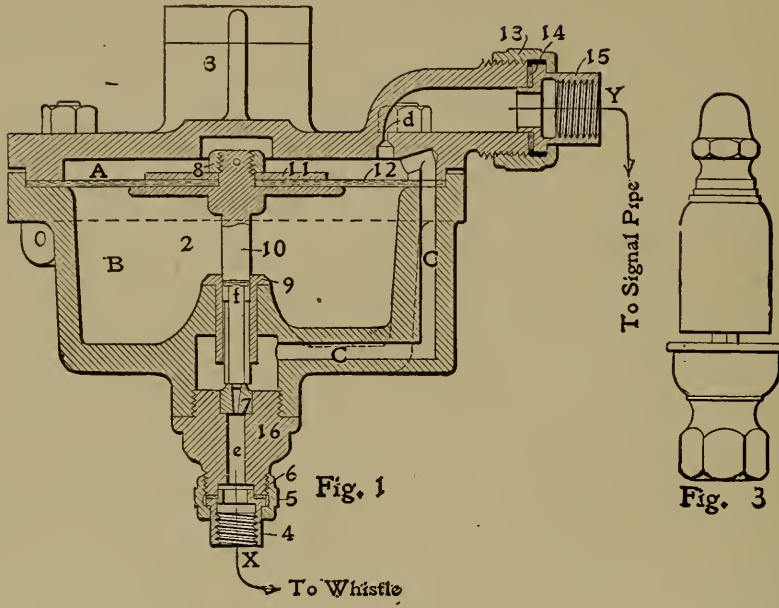


PLATE 42—FIGURES 1-2-3 and 4.

Operation of the Reducing Valve. The normal position of the reducing valve is open as shown in Fig. 4, Plate 42. When the valve is in this position, air enters from the main reservoir at connection A; the supply valve being off its seat permits the air to pass by the seat of this valve into diaphragm chamber C, thence through port *b* to the signal pipe connection B.

The signal line pressure is present at all times on the diaphragm, and when the desired pressure in the signal line is attained it exceeds the tension of regulating spring 13 and the diaphragm is forced to its lower position, permitting supply valve spring 6 to seat supply valve 4, thus shutting off the flow of air from the main reservoir to the signal line.

The purpose of the cut-out cock is to afford a means of cutting off the main reservoir pressure from the supply valve, whenever it is necessary to remove the valve for any purpose, with pressure in the main reservoir.

After the air has passed through the reducing valve it passes to the signal line throughout the entire train, and also to the whistle signal valve, causing it to become charged.

Adjustment. The valve is adjusted by removing cap nut 15 and tightening up regulating nut 14, which creates a tension on regulating spring 13.

SIGNAL VALVE.

Plate 42, Fig. 1, is a sectional view of the whistle signal valve in its normal position. The purpose of this valve is to regulate the flow of air to the signal whistle. The two compartments A and B are separated by diaphragm 12, and diaphragm stem 10 secured thereto extends through bushing 9, its lower end acting as a valve on seat 7 of cap nut 16, above passage *e*. Diaphragm stem 10 fits bushing 9 snugly for a short distance below its upper end, to where a peripheral groove is cut in the stem below which it is milled in triangular form.

Operation. While the system is being charged, air enters the valve from the signal line, passes through port *d* into chamber A,

above the diaphragm; also through port C and around piston stem 10 into chamber B, causing the air pressure to equalize above and below diaphragm 12. When a quick reduction is made in the signal line it causes a reduction of pressure in chamber A, above the diaphragm. The pressure in chamber B then being the greater, causes the diaphragm to raise, lifting signal valve 10 off its seat. The air pressure in chamber B passes by diaphragm stem 10 and unites with the air pressure passing through port C, thence through port *e*, below the valve stem, into the pipe leading to the whistle, which causes a blast. The same reduction of signal line pressure which causes the signal valve to operate also causes the reducing valve to open, which permits main reservoir pressure to flow into the signal line, restoring the pressure. This raises the signal line pressure and also causes pressure to be raised in chamber A, above the diaphragm, moving it to its lower position, as shown in Fig. 1. Equilibrium of pressure quickly occurs in chambers A and B, and the valve at the lower end of stem 10 returns to its seat.

CAR DISCHARGE VALVE.

The car discharge valve is usually located above the door outside of the car, and opposite the opening through which the signal cord passes. A branch pipe extends from the main signal pipe to the car discharge valve, and in this pipe is placed a one-half-inch cock, by means of which the valve on the car may be cut out when desired.

The pressure in the signal line is reduced by means of the car discharge valve, and can be operated from any part of the car by means of a cord known as the whistle cord.

Operative Parts. The operative parts of the car discharge valve are the Discharge Valve 3, Discharge Valve Spring 4, and Discharge Valve Handle 5. The normal position of this valve is closed, as shown in Fig. 2, Plate 42.

Operation. The valve is operated by means of valve handle



5, which is in the form of a lever. By moving this lever in either direction it forces discharge valve 3 from its seat, which compresses discharge valve spring 4, thus permitting air pressure to escape from the signal line to the atmosphere.

When operating the air whistle signal, the car discharge valve should be held open for at least one second in order to produce a proper blast of the whistle.

An intermission of about three seconds should be allowed between blasts on trains of five cars or less, and one second should be added for each additional car in the train. The spacing of the blasts is necessary in order to give the air pressure in the signal valve sufficient time to equalize above and below the diaphragm of the signal valve between each blast of the whistle (Fig. 1, Plate 42).

Overcharging Signal Line. Overcharging of the air signal line is usually due to there being a direct opening between the signal line and the main reservoir, which will allow air to flow from the signal line to the main reservoir each time the main reservoir pressure is reduced. This causes a reduction of signal line pressure at the signal valve, which, if the opening through the reducing valve is large enough and the main reservoir pressure is reduced sufficiently fast, will open the signal valve, causing the whistle to sound.

When the signal line is overcharged it can be detected from the train by a strong discharge of air from the discharge valve, and on the engine by the signal whistle, as the bell of the whistle is adjusted for a pressure of 40 pounds instead of 90 or 120.

Adjusting the Whistle. The whistle (Fig. 3, Plate 42) can be adjusted by loosening up the lock nut and unscrewing or screwing up the bell, occasionally making a reduction in the signal line and noting whether the proper sound is produced.

Testing Signal Line Pressure. A test of the pressure in the signal line can be made from the engine without the use of a test gauge by shutting off the air pump, gradually reducing the main reservoir pressure and watching the red hand of the gauge.

When the whistle blows the air gauge will indicate the pressure in the signal line.

DEFECTS OF THE AIR SIGNAL SYSTEM.

Failing to Charge. If the signal line fails to charge it should first be noted that it is cut in between the tank and the first car, that all angle cocks on the train are open, except the one on the rear end of the train, which should be closed, and that the reducing valve is cut in and properly adjusted. If the trouble still continues it may be due to the choke in the reducing valve becoming stopped up so that no air can pass through, a collapsed hose lining which would block the passage, or, in cold weather, the signal line between the tender and engine may be frozen.

Failure of Whistle to Sound. If the signal line is properly charged and an exhaust occurs at the discharge valve when the whistle cord is pulled properly, but the whistle fails to give a blast, the trouble may be due to the strainer in the tee pipe connection of the branch pipe to the signal line being partly stopped up; port *d* of the signal valve being stopped up so that no air can enter to charge it; stem 10 of the signal valve becoming worn sufficiently loose in bushing 9 to allow the pressure in chamber B to reduce as rapidly as that in chamber A; the signal valve diaphragm becoming baggy or having a hole in it; the passage in bushing 7 becoming stopped up, or stem 10 fitting too tightly in bushing, not allowing chamber B to charge; the bell of the signal whistle not being properly adjusted, or its bowl filled with dirt; the whistle being located so that the wind blowing across the bowl from an open cab window prevents it from sounding, or the choke in the reducing valve being too large, allowing the signal line to be charged as fast as the reduction is being made.

One long blast. If the air whistle gives one long blast it may be due to the reductions being made too close together, or diaphragm stem 10 working stiffly in bushing 9, in which event the passage at *e* would remain open until a sufficient difference of

pressure exists in chambers A and B to force stem 10 to its seat.

Two or More Blasts. If the air whistle gives two or more blasts each time the cord is pulled the trouble is due to a stiff diaphragm, or diaphragm stem 10 fitting too loosely in bushing 9, in which event the reduction in chamber A would allow chamber B to respond too quickly and reduce its pressure below that in chamber A, causing chamber A pressure to force stem 10 to its seat, and this would be repeated several times during one reduction of chamber A pressure.

Whistle Sounding When Brakes Are Released. If the air whistle gives a blast each time the brakes are released it indicates that the signal line pressure is charged up to that in the main reservoir, which is caused by the tension of the regulating spring being too great, the supply valve of the reducing valve being held from its seat, or a leak by the diaphragm, and the opening in the spring casing stopped up.

COMBINED FREIGHT CAR CYLINDER AND AUXILIARY RESERVOIR WITH TRIPLE VALVE ATTACHED.

The combined freight car cylinder and reservoir (Plate 43) is the usual form of equipment applied to freight cars. On a part of the cars in use the cylinders and auxiliary reservoirs are separated, but the triple valve, auxiliary reservoir and brake cylinder are the same in both cases. The auxiliary reservoir 10 is simply a hollow shell for the purpose of storing air for use in the brake cylinder upon the same car. Pipe *b* provides communication between the triple valve and the brake cylinder. Upon passenger cars this pipe does not pass through the auxiliary reservoir, but the operation of the brake is the same; it is simply a different arrangement of the same parts.

List of Parts and Their Purposes. 2 is the brake cylinder; 3 is the piston and sleeve in which the push rod connected with the system of brake levers is inserted; 4 is the non-pressure cylinder head; 9 is the release spring, which forces piston 3 to release position when the air pressure is released from the pressure end of the cylinder; 7 is a packing leather, which is pressed against the cylinder wall to prevent air from escaping past the piston; 8 is a round spring packing expander, which serves to hold the flange of the packing leather against the walls of the cylinder; 6 is the follower plate, which, by means of studs and nuts 5, clamps the packing leather to the piston, and *a* is a small groove, indicated by dotted lines in the wall of the cylinder, called the leakage groove.

If the exhaust port on the slide valve of the triple valve should in any manner become obstructed, when it is not desired to have the brakes applied, a slight flow of air into the brake cylinder will, instead of forcing the piston out, escape through leakage groove *a* to the atmosphere at the non-pressure end of the cylinder.

Valve 17, usually placed on the upper side of the auxiliary reservoir, is known as the release valve. A rod extends from the

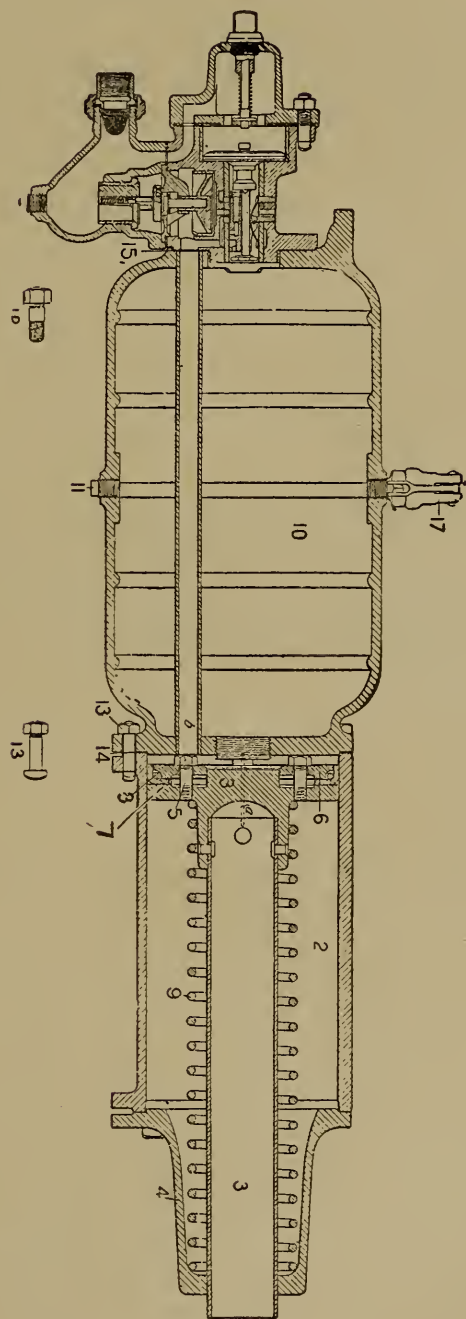


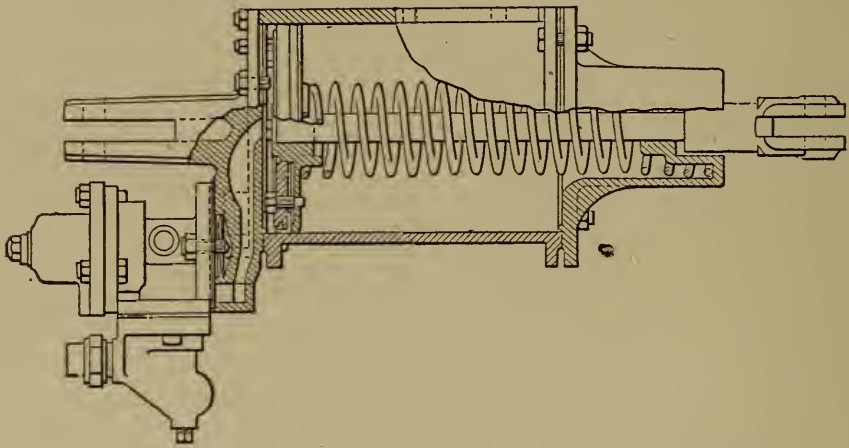
PLATE 43.

106 COMBINED CYLINDER & AUXILIARY RESERVOIR

arms of this valve to each side of the car. Pulling either rod unseats the valve and discharges air from the reservoir for the purpose of releasing the brake.

Sizes of Brake Cylinders. Brake cylinders with a diameter of 6, 8, 10, 12, 14 and 16 inches, and of various lengths, are used on cars of various capacities. The size of the brake cylinder is determined by the total light weight of the car resting on the rails.

Sizes of Reservoirs. A reservoir 10 x 24 inches is required with 8-inch cylinders on passenger cars; 10-inch cylinders are used with 12 x 33-inch reservoirs on passenger equipment; 12-



Westinghouse Passenger Car Brake Cylinder and Triple Valve.

PLATE 44.

inch cylinders are used with 14 x 33-inch reservoirs, passenger equipment; 14-inch cylinders with 16 x 33-inch reservoirs with engine, tender and passenger equipment, while with a 16-inch cylinder on passenger equipment a reservoir 16 x 42 inches is used. For freight car equipment, on which cylinders 6, 8 and 10 inches in diameter are used, a standard cast-iron reservoir of different sizes adapted to each size of cylinder must be used.

Plate 44 shows a sectional view of the passenger car brake cylinder with special head and triple valve attached to it, in the same manner in which the triple is connected to the auxiliary on freight equipment.

DEFECTS OF THE BRAKE CYLINDER.

Any leakage from the brake cylinder will cause the brake to release. This is usually caused by the packing leather becoming cut or very dry, and not forming an air-tight joint between the piston and the cylinder wall.

If the expanding ring is not placed in its proper position the packing leather will not be held against the cylinder wall, thus permitting a leakage. In some cases it will also bind the piston, preventing it from returning to release position after the pressure has been exhausted.

A broken or weak piston release spring will fail to force the piston to its normal or release position after the pressure has been exhausted from the cylinder.

If the leakage groove becomes stopped up and the exhaust port is obstructed, it will possibly cause the brake to set slowly, if a leak exists in the brake pipe, as the air that is admitted to the brake cylinder cannot escape past the piston.

AUTOMATIC SLACK ADJUSTER.

The automatic slack adjuster is a simple mechanism, by means of which a predetermined piston travel is constantly maintained, compelling the brakes of each car to do their full amount of work, thus securing from the brakes their highest efficiency, eliminating the danger of causing flat wheels, which is likely to occur with a wide range of piston travel. This device establishes the running piston travel, that is, the piston travel when the brakes are applied while the car is in motion, and, since this is the time during which the brakes perform their work, the running travel is the important one. Hand adjustment of brakes necessarily relies upon the standing travel, and it is only coarsely graded by the spacing of the holes in the dead lever guide.

Operation. The slack adjuster is shown on Plate 45, Figs. 1, 2 and 3. The brake cylinder piston acts as a valve to control the admission and release of brake cylinder pressure to and from pipe *b* (Fig. 1), through port *a* in the cylinder, this being so located that when the piston uncovers port *a*, brake cylinder air flows through pipe *b* into slack adjuster cylinder 2, where the small piston 19 (Fig. 2) is forced outward, compressing spring 21. Attached to piston stem 23 is a pawl extending into casing 24, which engages ratchet wheel 27, mounted within casing 24, upon screw 4 (Fig. 1). When the brake is released, and the brake cylinder piston returns to its normal position, the air pressure in cylinder 2 escapes to the atmosphere through pipe *b*, port *a* and the non-pressure head of the brake cylinder, thus permitting spring 21 (Fig. 2) to force the small piston to its normal position.

In so doing, the pawl turns the ratchet wheel upon screw 4 and thereby draws lever 5 slightly in the direction of the slack adjuster cylinder, thus shortening the piston travel and forcing the brake shoe nearer the wheels. As the pawl is drawn back to its normal position a lug on the lower side strikes projection *a* (Fig. 3) on the cylinder, thus raising the outer end of the pawl,

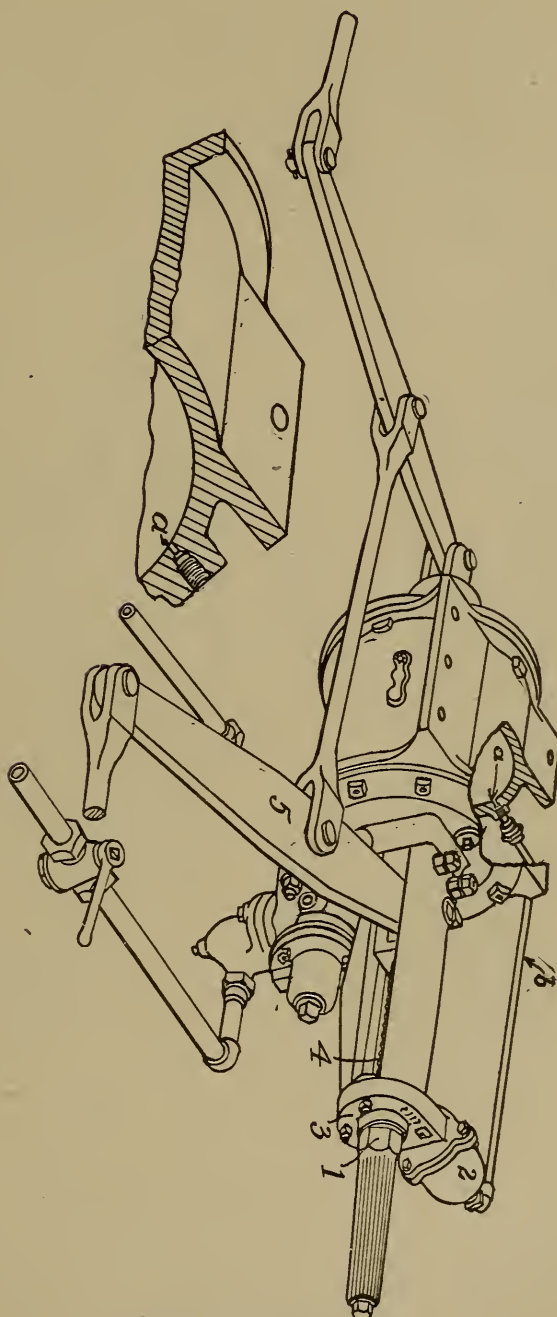
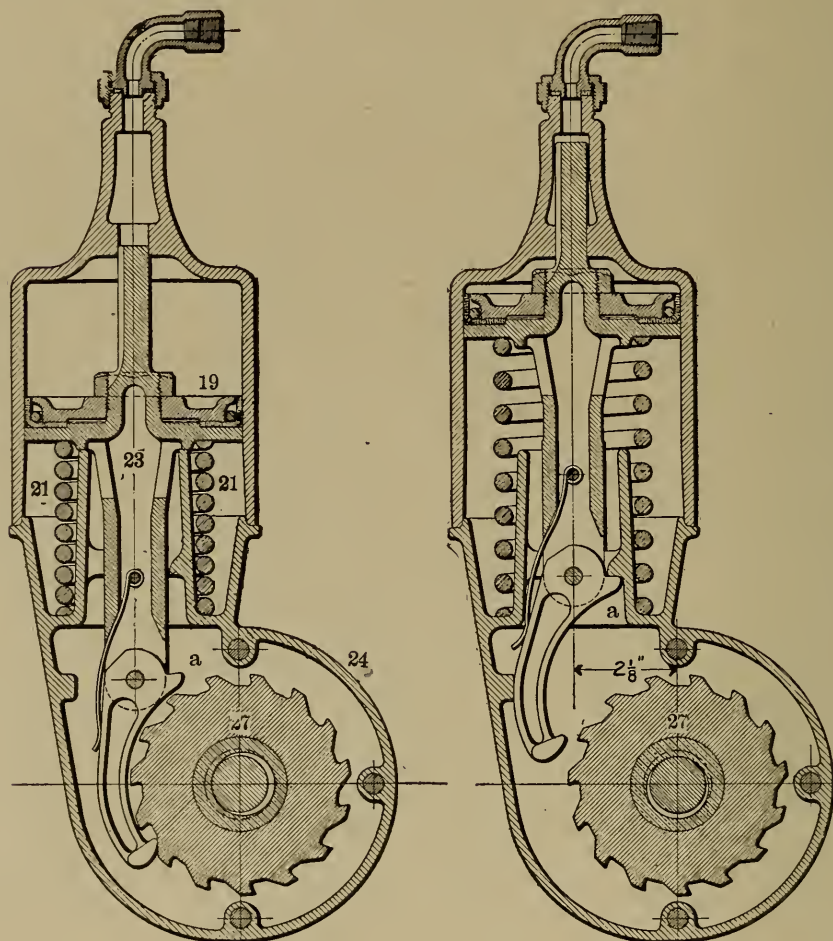


PLATE 45—FIGURE 1.

disengaging it from the ratchet wheel, and permitting the screw to be turned by hand if desired. The screw mechanism is so proportioned that the piston travel is reduced only about $1/32$ -inch by each operation, which removes the danger of unduly taking up false travel.



APPLIED

RELEASED

FIG. 2.

PLATE 45.

FIG. 3.

Improper Adjustment. If the piston travel is found to be too long when the small pipe leading to the adjuster cylinder is free from obstruction, and the packing leather in the adjuster cylinder is free from leakage, it is more than probable that the

slack has been taken up through an application, with only partial release of the hand brakes, and full release occurring only after the shoes have had time to wear. If the piston travel becomes too short, it will be found that some of the slack in the brake rigging has been taken up by the hand brake where the two work in opposition, or the dead levers have been moved.

Purpose of the Slack Adjuster. The purpose of the slack adjuster is to maintain a predetermined piston travel, as by constant wear the brake shoes become thinner, which causes the brake piston to travel farther and results in reducing the brake cylinder pressure and the holding power of the brake.

The automatic adjuster regulates the piston to its proper running or working travel, regardless of the length of travel, or whether the car has high or low leverage. Therefore, if all cars in a train were equipped with automatic adjusters, the travel of all pistons would be uniform when the brakes were set to slow down or stop the train, the same brake cylinder pressure would be had on all cars at each and every reduction, and all cars in the train would develop equal braking power.

As the work of the adjuster is based on running travel, the travel of the pistons will be uniform, but the standing travel of the pistons will not necessarily be uniform on all cars in the train.

PRESSURE RETAINING VALVES.

STANDARD PRESSURE RETAINING VALVE.

The standard type of pressure retaining valve, used on 6, 8 and 10-inch cylinders is shown on Plate 46, Figs. 1 and 2. It consists of weighted valve 4, enclosed in casing 3, and seating in passage *b*; this valve is screwed on to the farther end of a pipe leading to the exhaust port of the triple valve.

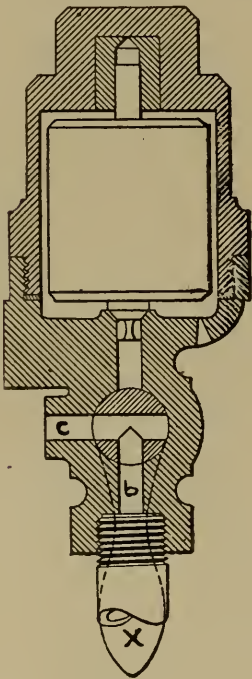


FIG. 1.

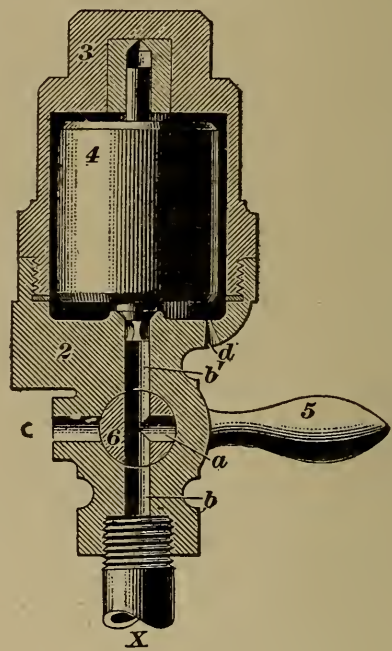


FIG. 2.

PLATE 46.

Operation. When the handle of the pressure retaining valve is turned downward, pointing perpendicularly (Fig. 1), the pressure escapes from the brake cylinder through the retaining valve pipe to the retaining valve, where it escapes freely to the atmosphere, entering the retaining valve at X, and passing through ports *b* and *c* to the atmosphere. In this position the valve is not in operation and has no duty to perform.

When the handle of the retaining valve is turned upward, pointing horizontally, the direct outlet from the retaining valve

pipe is closed. As shown in Fig. 2. the air is discharged from the brake cylinder through the triple valve, retaining valve pipe and ports *b*, *a* and *b*, as before. Port *c* now being closed, the air pressure must lift weighted valve 4 and pass to the atmosphere through the restricted port *d*. All pressure over 15 pounds will hold the valve from its seat and escape through a small port in the cage. This valve is so proportioned that it will seat only when 15 pounds or less pressure is exerted upon it. Thus the last 15 pounds is retained in the brake cylinder, which is sufficient to steady the train while the auxiliary reservoirs are being recharged.

The retaining valve not only holds a braking power of 15 pounds in the cylinders, but the passageway out of the casing to the atmosphere is restricted to such an extent that a considerable time is consumed in discharging the brake cylinder pressure through the small port. This renders the release of the brake much slower and exerts a retarding effect, which gives more time for the recharging of the auxiliary reservoir.

Difference in Sizes of Port *d*. Port *d* is not the same size in all retaining valves. It is 1/16-inch in the retaining valves used with 6, 8 and 10-inch cylinders, and 1/8-inch in those used with 12, 14 and 16-inch cylinders. These port sizes give a restriction which requires from 30 to 60 seconds for the cylinder pressure to escape down to the amount limited by the weighted valve. The figures given cover the standard retaining valve. This has been found by repeated tests to be the standard pressure for cars in interchange service, and gives good results in braking on long grades without excessive heating of wheels. In mountain districts there are other types of retaining valves used to some extent, but they are not considered standard, and are not in general use.

Advantages of the Retainer. The retaining valve also permits a much safer handling of trains, the maintenance of a more uniform rate of speed down heavy grades and a saving of air pressure. It gives an increased cylinder pressure and a higher

braking power with a lower consumption of air pressure, and in addition permits a greater reserve in stopping power for emergencies.

The retaining valve cannot be used to advantage in driver brake operation. This is due to the fact that driving brake packing generally leaks and the various connections in the brake cylinder pipe frequently become loose, causing a leakage. With these avenues of escape for pressure, the retaining valve is unable to perform its functions. The driver brake retaining valve has almost entirely given way to the combined automatic and straight air brake, which overcomes the leakage difficulties.

HIGH AND LOW PRESSURE RETAINING VALVE.

The great value of the standard pressure retaining valve in the safe handling of trains on heavy grades has been demonstrated repeatedly. The growing severity of modern braking conditions, as a result of which average loads of 73 tons per brake, on trains of 25 or more cars over grades of 200 feet to the mile, are frequently encountered, has brought about several methods of increasing the certainty of controlling such heavily loaded trains; one by raising the brake pipe pressure from 70 to 90 pounds, which gives a greater reserve for reapplication after release; another by increasing the percentage of braking power, and using the standard pressure retaining valve; a third by the introduction of a special pressure retaining valve.

The standard retaining valve is designed to maintain a brake cylinder pressure of 15 pounds while the auxiliary reservoirs are being recharged, and ordinarily this pressure is sufficient. Under extreme conditions, however, it has proved desirable to increase the amount of pressure retained in the brake cylinders, during the recharge of the auxiliary reservoirs, to 30 and sometimes 50 pounds. This condition has been met by the manufacture of a high and low pressure retaining valve which fully meets these requirements. It will be understood that this valve is only an

accessory to the regular brake apparatus and is not intended to replace the more important factors required in heavy freight service, such as adequate braking power, proper size cylinders, suitable leverage, and the exercise of good judgment in the maintenance and operation of the brakes.

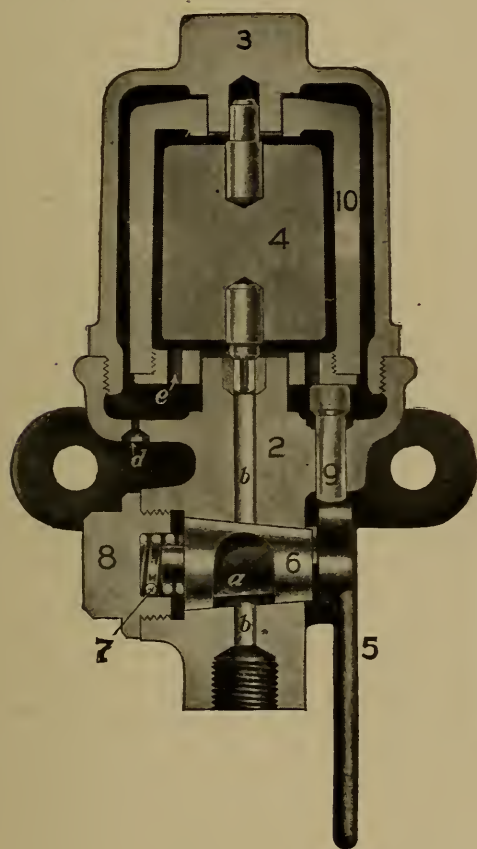


FIG. 1.

PLATE 47.



FIG. 2.

Operation. This new retaining valve is very similar to the standard type in general design and location, but is modified as indicated on Plate 47, Figs. 1 and 2. The main difference consists in the addition of a cylindrical weight 10, which surrounds the usual weight and is lifted by it, whenever valve handle 5 is manipulated to retain 30 pounds. When handle 5 is placed in a horizontal position, one of two eccentric lugs on it raises pin

9 and also outer weight 10, the latter to the top of its movement. During such time inner weight 4 alone retains the pressure.

If the handle is placed in the intermediate position marked "high pressure" (Fig. 2), neither eccentric lug nor handle 5 touches lifting pin 9, and consequently outside weight 10 rests upon the top of inner weight 4, and the air pressure must raise both weights before it can escape to the atmosphere. When the handle is placed vertically, as shown in Fig. 1, the air passes directly to the atmosphere, thus cutting out the retaining valve, while at the same time the other eccentric lug on the handle raises the lifting pin and outside weight, so that the small weight alone rests on the valve seat.

Positions of the Handle. The exhaust and low pressure positions of this retaining valve are similar to those of the standard retaining valve. Thus, when cars equipped with this valve are running in localities free from heavy grades, where the train crews are familiar only with the standard valve, they cannot by mistake place the handle in the high pressure position. The letters "H. P." and "L. P.," indicating respectively high pressure and low pressure, are cast on the body of the valve, so as to assist still further in indicating the positions of the valve handle.

The development of this device was coincident with a series of interesting and valuable tests made by a leading railway company with a view of determining what is actually required to hold heavy trains under perfect control when descending heavy grades, through using higher air pressure, special pressure retaining valves, water brake on the locomotive, and the combined automatic and straight air brake equipment on the engine and tender. The results of these tests indicate that to control such trains suitably, the minimum brake pipe and auxiliary reservoir pressures should not fall below 70 pounds, in order to give sufficient reserve braking power to stop the train on a heavy grade in cases of emergency.

This at once necessitates an increase in air pressure throughout the system, as standard maximum brake pipe pressure is 70

pounds. Although this increase was provided, this change alone did not suffice to control the trains, and a special high and low pressure retaining valve was introduced, which was designed to retain a cylinder pressure of 25 pounds for use upon grades of $2\frac{1}{2}\%$ or less, and 50 pounds for grades approximately 4%. It should be stated, however, that the conditions surrounding these tests were extreme, and that the high and low pressure retaining valves furnished as standard are proportioned for 15 and 30 pounds respectively.

DEFECTS OF THE RETAINER.

If there is a steady leakage of pressure at the retaining valve when the brake is released, the trouble will be found in the triple valve.

If the retaining valve handle has been turned upward in a horizontal position, the brakes then released, and after a few moments the handle is turned downward and no air escapes, the trouble is not in the retaining valve, but is caused by a leaky joint or connection in the pipe, or by the valve being held from its seat by dirt. If there is no leakage it indicates a leak at the brake cylinder packing.

If air fails to pass through the retaining valve, with the handle turned down and the brakes remain set, the trouble should be looked for at the exhaust port, which may have been stopped up by an accumulation of dirt.

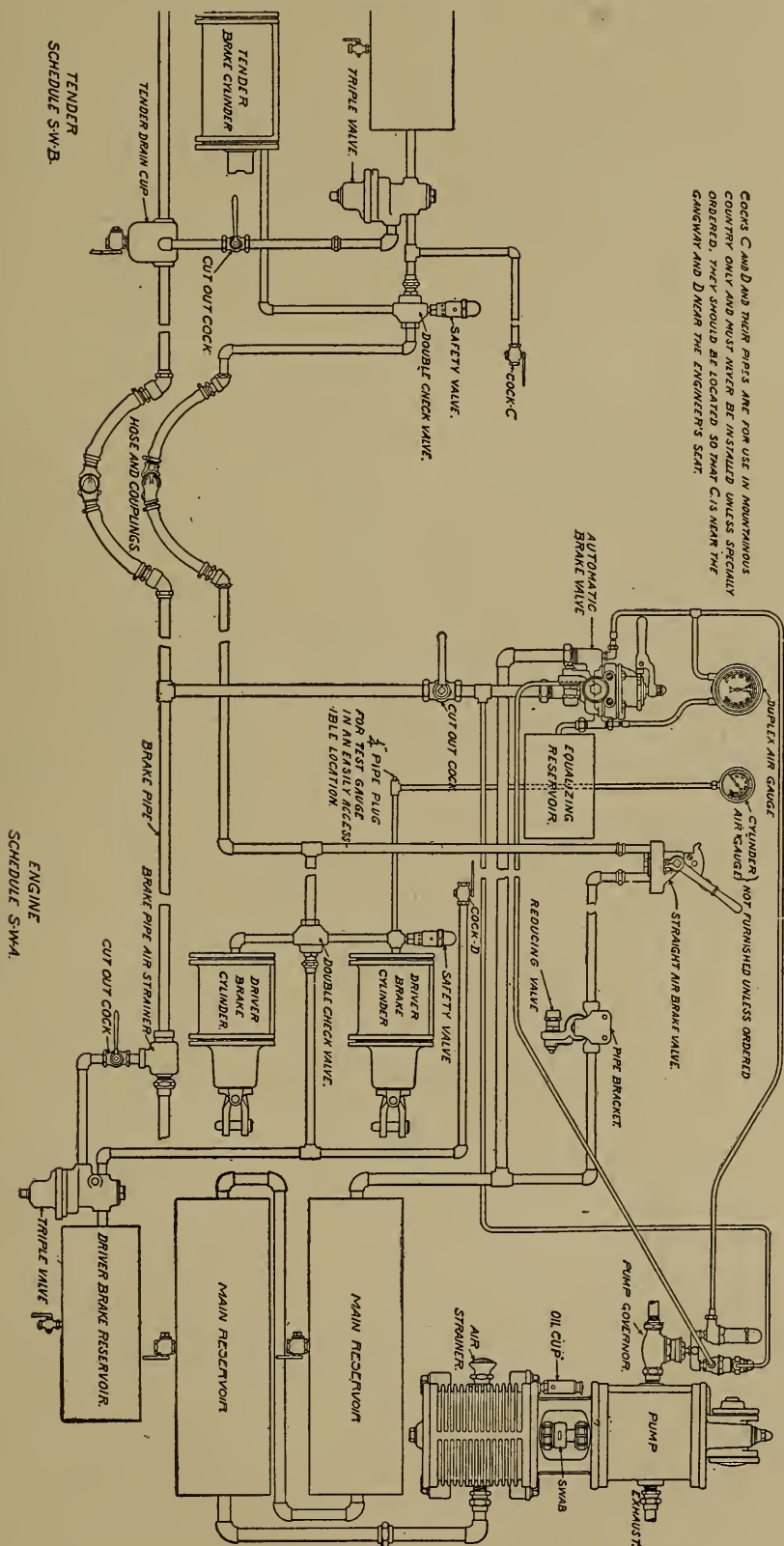
COMBINED AUTOMATIC AND STRAIGHT AIR LOCOMOTIVE BRAKE EQUIP- MENT.

The combined automatic and straight air engine and tender brake, shown diagrammatically on Plate 48, consists of the standard automatic arrangement employed on engine and tender, with the addition of a straight air brake valve, reducing valve, two double check valves, two safety valves, a straight air gauge, special hose and necessary piping, which permits the use of straight air on the engine and tender brakes without interfering with their automatic action when the automatic brake valve is used, both being cut in at all times. The many important advantages of an independent engine and tender brake are thus obtained, while preserving at all times every function of the automatic on these and the train brakes. Without this latter requisite no independent brake can be considered either safe or economical.

The straight air is used for passenger, freight and switching locomotives. The parts for the engine are known as schedule S-W-A and for the tender as schedule S-W-B.

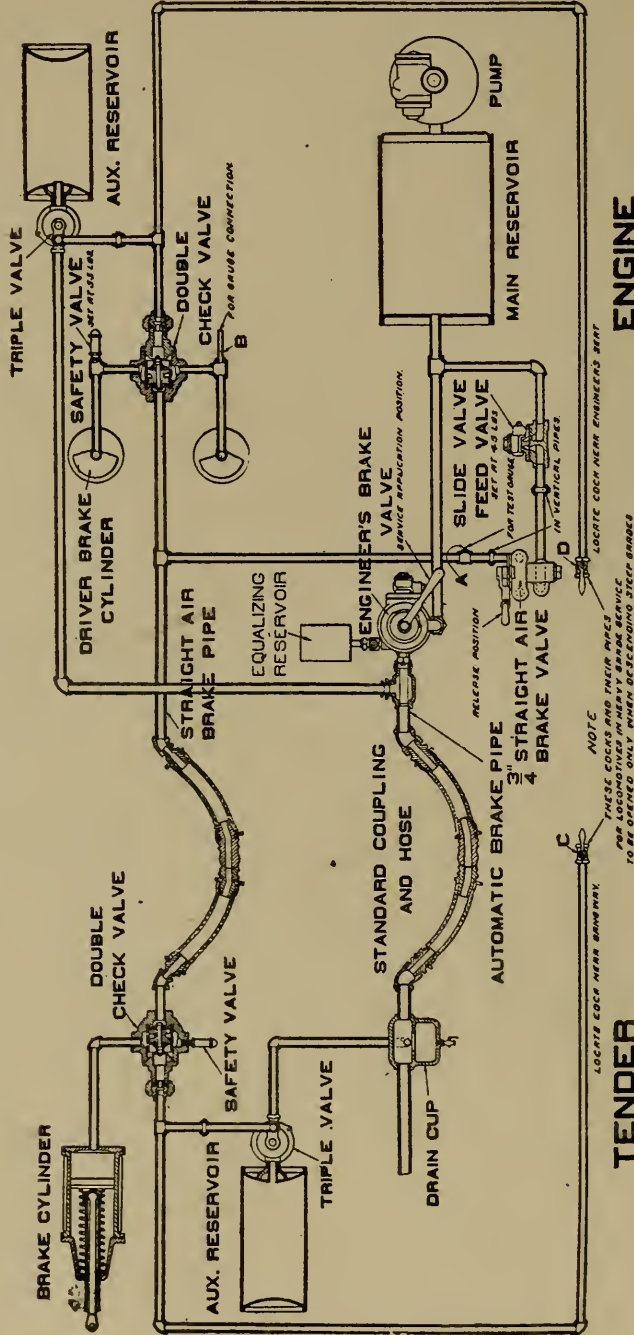
General Arrangement. Plate 49 shows the general arrangement of the combined apparatus and the positions of the brake valves and double check valves when the automatic brake is applied. Plate 50 shows the corresponding positions when the straight air brake is applied. Connection with the automatic is made at three points, viz.: to the main reservoir and the brake cylinder pipes of the driver and tender brakes.

The straight air supply is taken from the main reservoir pipe between the main reservoir and the automatic brake valve so as to insure clean, dry air. Before reaching the straight air brake valve it must pass through the reducing valve, which is set at 45 pounds, and consists of a standard slide valve feed valve, as used on the automatic brake valve, attached to a special pipe connection made for that purpose. This reducing valve should always



COCKS C AND D AND THEIR PIPES ARE FOR USE IN MOUNTAINOUS COUNTRY ONLY AND MUST NEVER BE INSTALLED UNLESS SPECIALLY ORDERED. THEY SHOULD BE LOCATED SO THAT C IS NEAR THE GANGWAY AND D NEAR THE ENGINEER'S SEAT.

PLATE 48.



ENGINE

SCHEDULE SWA

TENDER

SCHEDULE SWB

be located in the cab, preferably at a point where it will be prevented from freezing in cold weather.

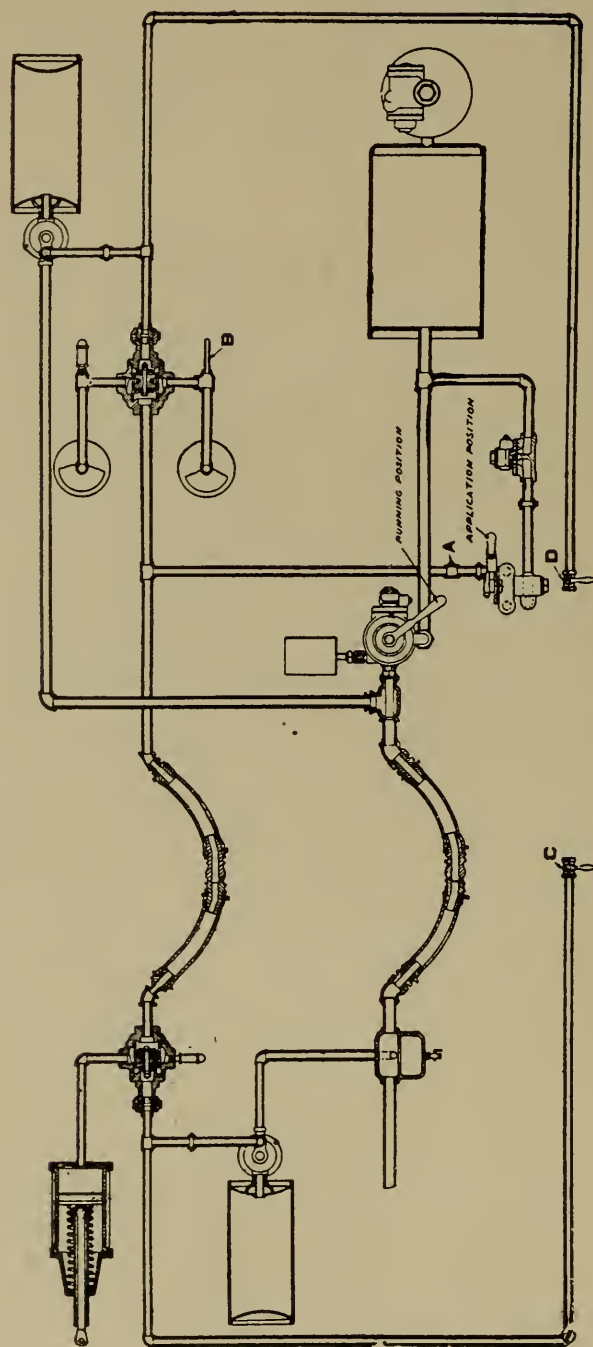
The double check valve on the engine and tender is connected as shown. The air must pass through this valve when either applying or releasing the brakes with the straight air or automatic equipment.

The two side openings of the double check valve (Plate 56) are the brake cylinder connections, joined by a cored passageway. The safety valve on the tender may be screwed into one of the cylinder connections of the double check valve, as indicated in the cuts, or in the pipe between the double check valve and the cylinder. On the engine, one brake cylinder should be connected to each of the double check valve cylinder connections, and the safety valve in either driver brake cylinder pipe.

Each safety valve should be adjusted to open at 53 pounds. It should be in direct communication with brake cylinder pressure, whether the automatic or straight air is used, and should be placed vertically to prevent dirt and water from accumulating inside of the valve.

As the straight air should never give over 45 pounds cylinder pressure, and the automatic not over 50 pounds, a correctly adjusted safety valve will never operate unless an improper condition exists, but when it does exist it will guard against a dangerously high cylinder pressure.

The grade cocks C and D with their pipes are for use only on locomotives operating over heavy mountain grades. They are to be opened only when descending very long grades and should be closed immediately upon reaching the foot of the grade. Cock C should be placed adjacent to the gangway so that it can be operated when running, and cock D should be placed near the engineman's seat. When descending heavy grades both cocks are left open. The driver and tender auxiliary reservoirs are recharged simultaneously with those of the train, but automatic application is prevented on the brakes of the former, thus permitting the greatest use practicable, without danger of loosening



DIAGRAMMATIC ILLUSTRATION OF COMBINED FREIGHT ENGINE EQUIPMENT WHEN
STRAIGHT-AIR BRAKE IS APPLIED

the tires of the tender and engine, when recharging the train brakes. A and B, Plate 49, indicate the gauge connections, a gauge for straight air being absolutely necessary for satisfactory service. The gauge should be connected so as to show the brake cylinder pressure in the automatic as well as the straight air applications, such connection being indicated by B. For attaching a test gauge, a tee should be put in the pipe from the straight air brake valve to the double check valve. It should be placed close to the former so that by taking out the $\frac{1}{4}$ -inch plug in its side opening and connecting a gauge, the latter can readily be seen while operating the brake valve and adjusting the reducing valve.

REDUCING VALVE PIPE BRACKET.

Plate 51 shows the special pipe bracket to which a standard slide valve feed valve, acting as a reducing valve for the straight air, is connected. Inlet port A and outlet port B come opposite the similar ports in the feed valve. The arrow shows the direction of the flow of air across the dividing wall.

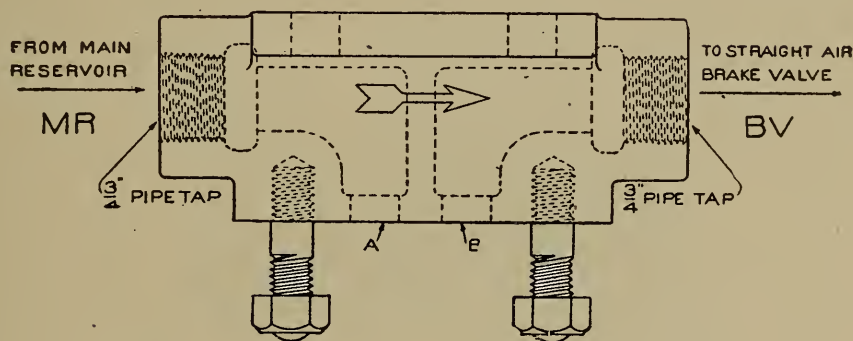


PLATE 51.

The B-3 reducing valve, shown on Plates 24 and 25, is the well-known feed valve that has been used for many years in connection with the G-6 brake valve, and this valve is also used and attached to a pipe bracket.

To adjust the valve, the cap nut on the end of the spring

box should be removed, which will expose the adjusting nut by which the adjustment is made. It is called a reducing valve when used with the straight air brake valve, simply to distinguish it from the feed valve supplying the automatic brake.

STRAIGHT AIR BRAKE VALVE.

Parts and Their Uses. Plate 52 is a sectional view of the straight air brake valve parallel with shaft 2, operated by handle 4, which opens application valve 8 or release valve 9. As indi-

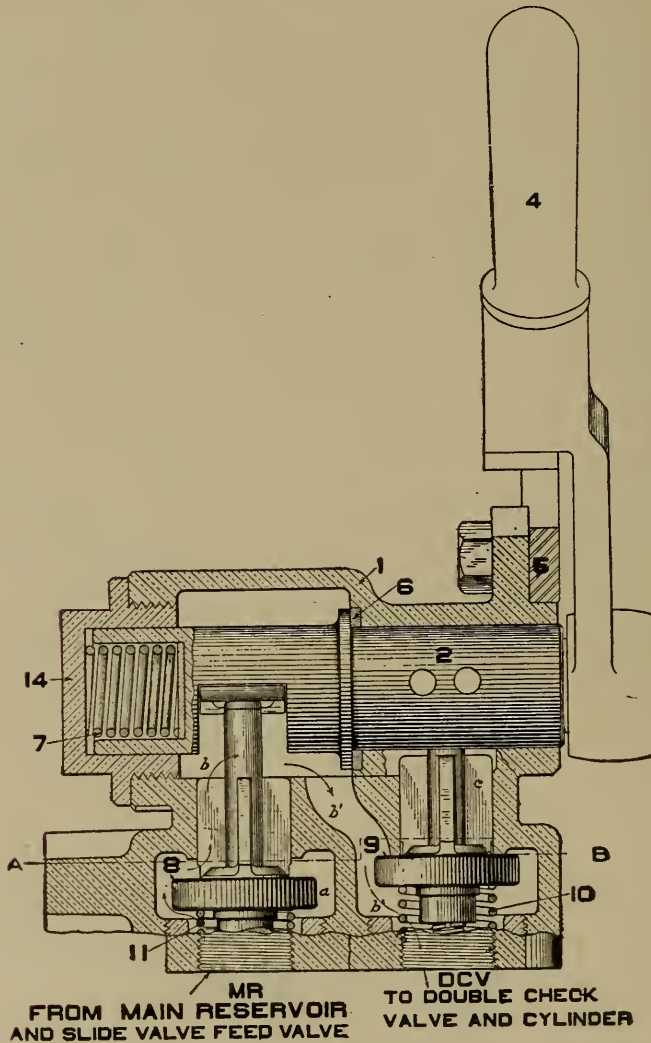


PLATE 52.

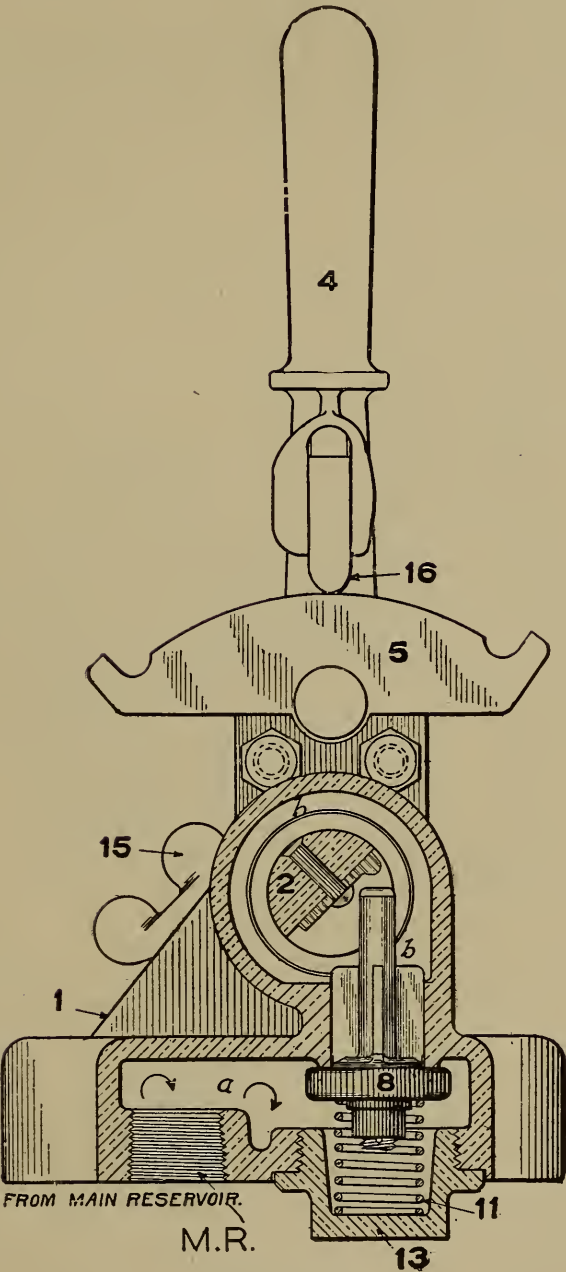


PLATE 53.

cated by *b*, *b'* and *b''*, the space above admission valve 8 is connected with that below exhaust valve 9. The leather gasket 6 makes the joint at the shaft collar.

Operation. Plate 53 is a sectional view across the shaft at application valve 8, showing the connection MR by which main

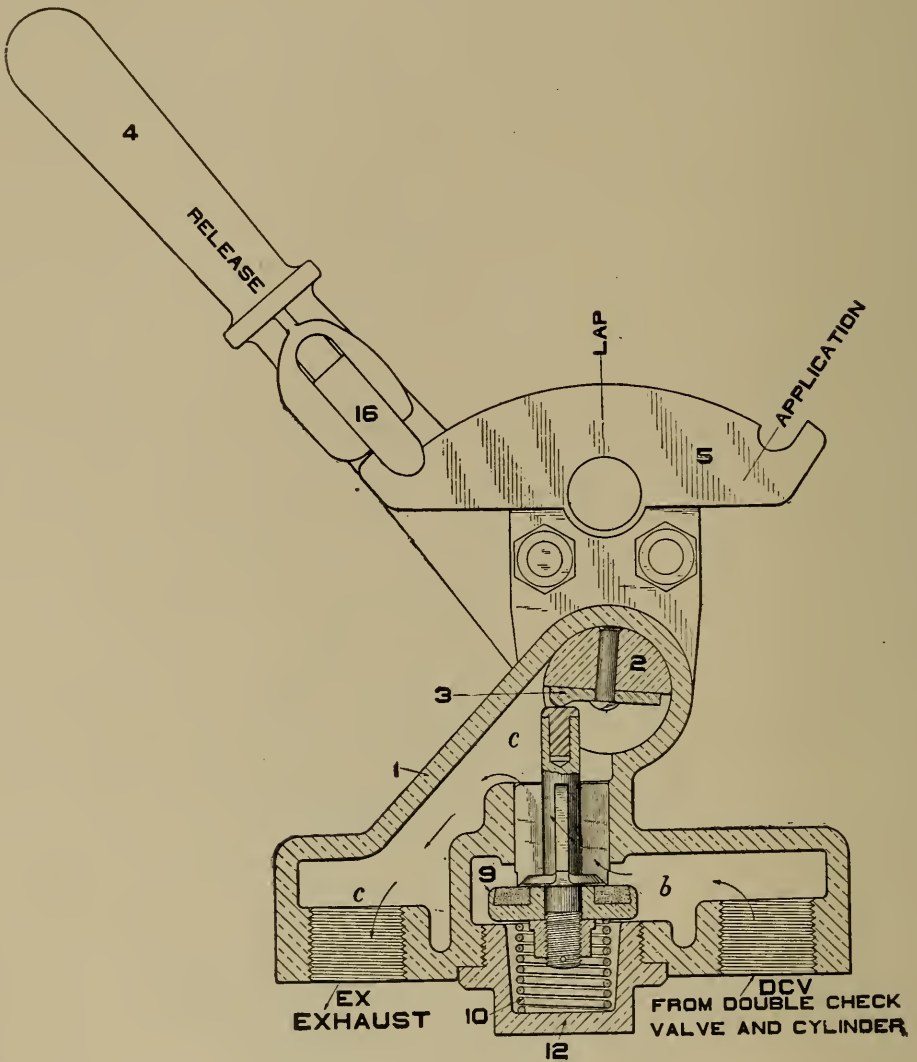
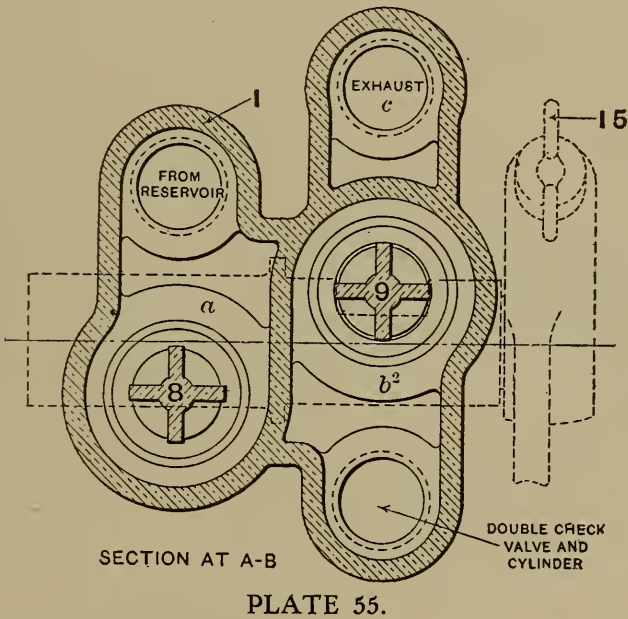


PLATE 54.

reservoir pressure, reduced to 45 pounds, reaches the lower side of valve 8, through cavity *a*.

Plate 54 is a similar section across the shaft at exhaust valve 9, showing the cavity *b* below this valve, the brake pipe connection at DCV, leading to the double check valves and past them to the brake cylinders; also passageway *c* leading from above release valve 9 through the exhaust opening to the atmosphere. Plate 55 is a horizontal section showing the relative positions of the valves and connections.

Shaft 2 is slotted out to the middle at two points, and valves 8 and 9 are just enough off the shaft center line so that the stem



of each valve will end just beneath the flanged portion of the steel tapped piece riveted into each of the shaft slots. As shown by the sectional view (Plate 54) of valve 9, these valves are fitted with leather seats and have steel caps to reduce the wear.

In Plate 53, handle 4 is shown in lap position, valves 8 and 9 being held to their seats by springs 10 and 11, and any air pressure that may be below them. This position embodies the space that can be covered by the handle movement without unseating either valve. Moving handle 4 (Plate 52) to the right unseats application valve 8 and allows main reservoir pressure to flow

from chamber *a*, past valve 8 to chamber *b*, thence through passage *b'* to *b''*, bringing it under release valve 9 and in communication with the pipe at DCV, by which it is carried to the double check valves and, past them, to the cylinders, applying the brakes. Moving handle 4 in the reverse direction (Plate 54) will permit application valve 8 to seat, unseating release valve 9 and releasing the brakes.

NO. 2 DOUBLE CHECK VALVE.

Plates 56 and 57 show the double check valve in section, the several connections being indicated thereon. Between the two seats, *b* and *d*, is piston valve 10, which has a leather face on

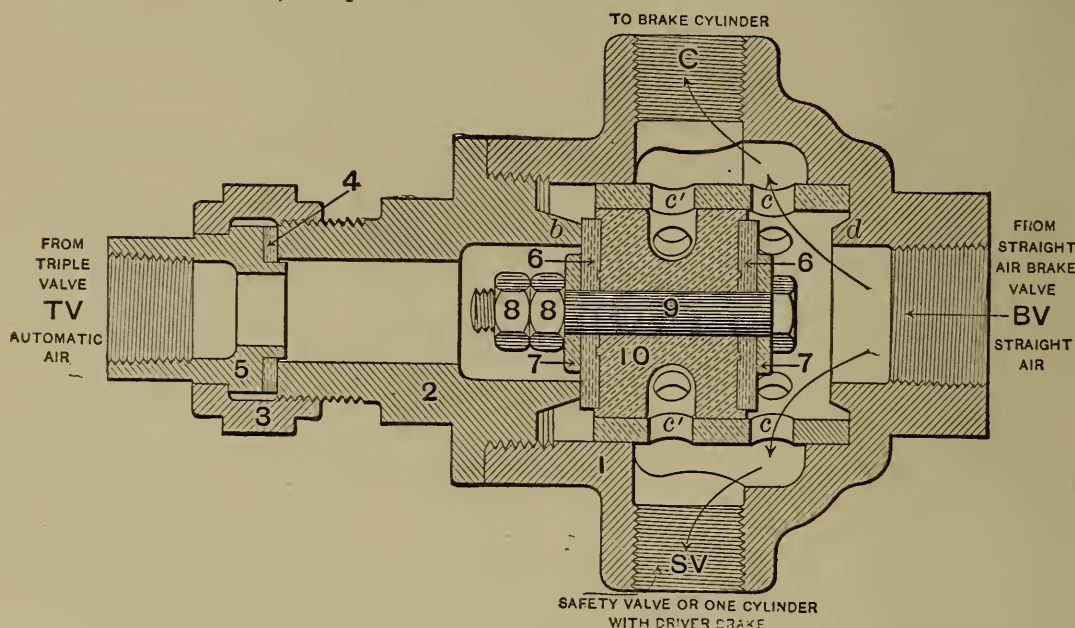


PLATE 56.

each end. The piston valve is shorter than the distance between its two seats, and the bushing in which it works has two series of ports, *c* and *c'*. When the piston is against seat *b*, as shown on Plate 56, port *c* opens a free passage for the air between the straight air brake valve and the brake cylinder. The opening leading to the triple valve, which is now in release position, is closed so that no leakage can occur.

Release Position. When the straight air brake valve is in release position (its normal position when not in use), and an automatic application is made, the air from the triple valve upon entering the double check valve will force the piston valve to the right against seat *d* (Plate 57), thus preventing any escape of pressure at the straight air brake valve, and opening ports *c'* so that air can flow into the brake cylinder, returning the same way when released.

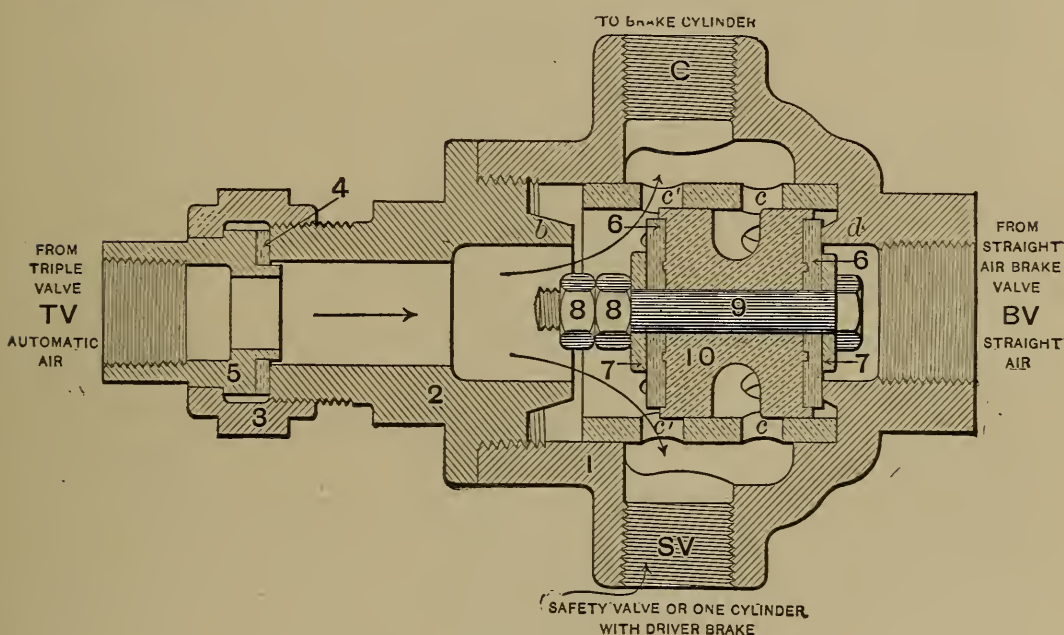


PLATE 57.

Position of Double Check Valve. The double check valve must be placed in a horizontal position so that its piston valve will not be moved except by air pressure. The use of either automatic or straight air will cause its piston valve to move automatically to the proper position.

Grade Bleed Cocks. As grade bleed cocks are connected between the driver and tender triple valves and their double check valves, when left open they will prevent automatic action on these brakes by allowing the air to pass directly to the atmosphere instead of through the double check valves.

TYPE "E" SAFETY VALVE.

Operation. Plate 58 shows the type "E" safety valve. Valve 4 is held to its seat by the compression of the spring between stem 5 and adjusting nut. 7. When the pressure below valve 4 is in excess of the tension of the spring, the valve raises, being guided in its movements by the brass bushing in body 2. Ports are drilled in this bushing, one outward through the body to the atmosphere, and the other upward to the spring chamber. Al-

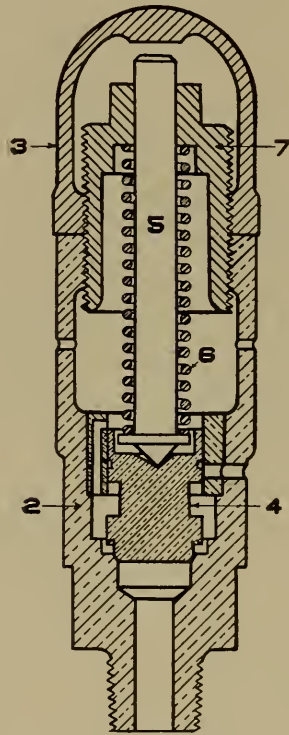


PLATE 58.

though only one of each of these ports is shown in the cut, there are in reality eight of the first and two of the second. As the valve moves upward, its lift is determined by stem 5 striking lock nut 3, which closes the vertical ports connecting the valve and spring chambers and opens the ports to the atmosphere. As the area of the valve is large, and there are a number of these ports leading to the atmosphere, a large volume of air will be released quickly. As the air pressure below valve 4 decreases, and the

tension of the spring forces the stem and valve downward, the valve gradually closes the ports to the atmosphere and opens those between the valve and spring chambers. The exhaust air then has access to the spring chamber.

Although the spring chamber is connected with the atmosphere by two small ports or holes, drilled through body 2, the air entering from the valve chamber through the vertical ports in the bushing will not flow to the atmosphere unless a pressure head is realized in the spring chamber. This pressure, added to that of the spring, causes the valve to close quickly with a "pop" action, which insures its seating firmly and completely.

This action, together with the large quantity of air passing through the valve when discharging, keeps the valve and its seat clean and in good condition, thus prolonging its life and insuring its proper operation and reliability. Also the difference between the opening and closing pressures is minimized, and the sensitiveness of the valve in operation greatly increased, causing it to respond to very slight differences in pressure and to close promptly when the pressure is reached for which it is regulated.

Reducing and Safety Valve Adjustments. If the straight air reducing valve is set at too low a pressure, the brakes will not hold well, but the automatic action will not be affected. The adjustment of the reducing valve should not be changed without the use of a gauge which is accurate.

Any pressure above 45 pounds will give more brake power than is desired, and if it is above 53 pounds it will cause the safety valve to blow and waste air with a full application of the brakes.

Safety valves that are set too low or that leak when seated will also cause a waste of air. If the safety valves are set too high they will not prevent an excessive cylinder pressure, and in cases where the reducing valve is adjusted too high or is out of order, or if the automatic is applied with the straight air set, the wheels are liable to slide.

Unless the straight air has a separate gauge, or one that can

be temporarily attached, as indicated at A and B (Plate 49), the best plan, when cleaning and adjusting are required, is to replace the safety valves and the feed valve part of the reducing valve with others that have been put in good order.

The safety valves should be set so that they will just commence to blow with a pressure of 53 pounds, after which the reducing valves should be regulated to act at 45 pounds pressure.

One of the best methods of adjusting the reducing valve when the air gauge is known to be correct is to clean and lubricate the slide valve feed valve on the brake valve, and adjust it at 45 pounds. All the air pressure should then be reduced, and this reducing valve exchanged with that on the straight air. The latter should then be cleaned and lubricated, and adjusted to the standard brake pipe pressure.

ADVANTAGES OF THE COMBINED AUTOMATIC AND STRAIGHT AIR BRAKES.

The purposes of the combined automatic and straight air brakes are as follows:

FIRST.—To quicken the work of switching and reduce the incident damage to lading and equipment.

With the straight air brake drawing its supply of air from the main reservoir, the holding power and possible speed of application never varies from one application to another; the release, if so desired, is practically instantaneous. The holding power of the brakes can be increased or diminished either quickly or slowly as desired, and the maximum pressure is not affected by ordinary leakage, or by long piston travel, unless the latter is sufficiently long to permit of the piston striking the head. With the straight air, unlike the automatic, it is possible to make a partial release, and this may be made with any desired rapidity. Application immediately after release is never delayed as with the automatic, when there is an overcharged brake pipe and a reduced auxiliary reservoir pressure. The driver and tender brake cylinders being

connected when using straight air, the distribution of brake power is not affected by variation in piston travel or cylinder leakage, and there is therefore less danger of wheel sliding.

SECOND.—To permit the brakes on long trains to be released without danger of slack running out suddenly and breaking the train in two, which is otherwise liable to occur at slow speeds. Allowing the train brakes to be released with safety at slow speeds prevents the loss of time and occasional damage incident to starting the train in an unfavorable location, at which a stop is necessitated, by reason of the engine not being equipped with straight air brakes.

THIRD.—To prevent changes of grade, sags, or curvature of tracks from running the slack of long trains in or out so suddenly as to cause severe shocks and train separation.

FOURTH.—To slow up or stop trains when the braking power required is not heavy. This reduces pump labor, wheel sliding and the break-in-tuos incident to an endeavor to start long trains with brake shoes dragging, or stuck brakes in the rear. It also reduces the number of stuck brakes, which are in all probability indirectly caused by a number of light applications with the automatic brake.

A light application of all brakes on a long train gives very little return in holding power for the amount of air used, as only a small amount of air passes into the cylinders. A little is lost through the leakage grooves, and much more in filling the space behind the pistons to the pressure required to overcome the resistance of the cylinder release spring and brake rigging. With the straight air acting only in the two driver and one tender brake cylinders these losses are insignificant.

The absence of brake beam springs on freight cars requires train movement to loosen the shoes from the wheels, where brakes have been held on until a stop has been made. By rendering it safe to release the automatic at slow speeds, and by avoiding the use of the latter where the required brake power is moderate, this dragging of brake shoes can be avoided.

FIFTH.—To prevent the slack from running out, and to aid the pressure retaining valves in controlling the speed while recharging on descending grades. The lower speeds and more thorough recharging of auxiliary reservoirs are thus attained, and increase the factor of train safety far more than is possible with the most efficient uses of the automatic brake on the driver and tender brakes in connection with the train brakes.

SIXTH.—To hold the train or locomotive and keep the automatic brakes recharged when standing on grades, thus having the train brakes ready for instant use at the start, which increases the factor of safety when it is necessary to do work on or under the engine. The application position of the straight air brake valve renders it impossible for the driver and tender brakes to leak off, and prevents the locomotive from moving when no one is present, even though the throttle leaks.

To many it will prove a surprising fact that, with the train standing and the slack bunched, straight air brakes on the engine and tender will hold a train on quite a heavy grade. In this its power is far greater than is possible with steam used for this purpose. The starting of undercharged trains, having a reduced pressure through previous brake application and subsequent leakage, is a dangerous feature too frequently met with in heavy grade service.

SEVENTH.—To control speed while weighing cars; straight air facilitates this work and decreases rough handling.

EIGHTH.—To increase mileage between tire turnings and decrease the damage to frogs and switches by badly worn tires.

NINTH.—To decrease the repairs and improve the average conditions of the automatic brake valve, by lessening the necessity for the use of the emergency application, as well as the use of the service application.

TENTH.—To decrease the wear of locomotive valves and cylinders by eliminating the necessity for reversing when in motion, which is experienced with the automatic brake on account of its comparatively slow recharging.

ELEVENTH.—To assist passenger trains in making smooth stops at water tanks, stations having short platforms and other points where accurate stops are required, and to hold passenger trains on grades after the automatic brakes are released.

Both the automatic and straight air should always be cut in and ready for operation unless the failure of some part requires the cutting out of one or the other.

An excess pressure of 10 pounds or over should be carried in the main reservoir, to insure a uniform and satisfactory operation.

Positions of Straight Air and Automatic Brake Valves. The straight air brake valve should always be kept in release position when using the automatic brakes, and the automatic brake valve kept in running position when using the straight air, to prevent sticking of the driver and tender brakes.

Use of Automatic Brake. Except in cases of emergency, the automatic brake must not be used on a train while the straight air is applied on the engine and tender. The straight air should be released before using the automatic.

Use of Straight Air During Automatic Application. The use of straight air while the automatic is applied will not increase the driver and tender brake cylinder pressure above 45 pounds, yet the release of neither is assured while the other brake valve is in lap or application position.

Power of Straight Air Brakes. The action of the straight air on the driver and tender brakes is almost as powerful as that of the automatic brakes. Care must be used when applying either brake to avoid rough handling of the train, and, in holding the train down a long grade, to avoid loosening of tires on the drivers. When the straight air is used to aid in recharging trains in motion, the automatic should be kept inoperative by having the one-half-inch cocks, shown at C and D, Plate 48, open.

Releasing at Low Speeds. To release the train brakes at low speed the straight air should be applied immediately before or after moving the automatic brake valve to release position, and a

strong straight air holding power maintained until all train brakes are released. Then, if no stop is to be made, the straight air should be gradually released and steam used carefully if needed until the train slack is all out.

Holding or Stopping Trains With Straight Air. In using the straight air to slow down a train from ordinary speeds, to stop it on an ascending grade, or on a level at slow speeds, the slack should first be gradually run in or out according to the direction of the movement. The slower the speed, the more holding power the same cylinder pressure will give, due to the greater brake shoe friction. For this reason the straight air should be partially released just before stopping in order to relieve the coupler spring tension and reduce the danger of wheel sliding. If on an ascending grade, the straight air should be fully released as soon as the stop is made, and reapplied lightly as soon as the train starts back, in case this occurs.

Piston Travel. To insure quick work and economy in air, the piston travel should be normal and cylinder leakage avoided, both with straight air and automatic brakes. The piston travel increases more rapidly with straight air than with the automatic alone, as because of its greater use more frequent adjustment is necessary.

Switching. When doing "short" switching with an engine having brake cylinders with long piston travel, or when making applications in rapid succession, to release the brakes, the air pressure should be lowered only until the brakes do not hold. This will economize in the use of air and hasten the following application. The straight air brake valve should be kept in release position at other times when holding power is not wanted.

Holding Standing Trains on Grades. To hold a standing train on an ascending grade, the slack should be taken out of the train by using the steam and then applying the straight air. If on a descending grade, and grade cocks C and D are open, the slack should be run in by using the straight air just as the stop is being completed; or if the train is already stopped, the loco-

motive should be reversed, the automatic brake valve moved to release position, and the straight air applied. The automatic brakes should be kept recharged when holding the train with the straight air, as this is the main object sought.

When holding the train with straight air, the brake valve should be left in full application position.

Recharging Train Brakes. When using the straight air to aid in recharging the train brakes when descending a heavy grade, grade bleed cocks C and D. (Plate 50) should be opened, after passing the summit of the grade. This will prevent the automatic from acting on the driver and tender brakes, but their auxiliary reservoirs will be recharged with those of the train. The straight air may then be used irrespective of the automatic, but care must be exercised to avoid rough handling and overheating of the driver tires. If cut-out cocks C and D were not opened, and the straight air and automatic brakes were used alternately down heavy grades, driving and tender wheels would become overheated.

The straight air should be used not only to aid in holding the train while recharging the brakes, but also to avoid a possible jerk from slack running out, when the speed is very low, just before releasing the brakes for the purpose of recharging.

Closing Grade Bleed Cocks. Grade bleed cocks C and D should always be closed on reaching the foot of a grade. If they are left open and a break occurs in the hose or brake pipe, causing a reduction of pressure in the brake pipe, no application of the automatic brake would follow on the engine and tender.

Leaving Brakes Set. The straight air brake valve should remain in application position when the engine is brought to a stop for the purpose of oiling, taking coal and water, or when leaving it for a time, to insure against any movement of the engine.

Engine Brakes Failing to Release. A failure of the driver and tender brakes to release indicates that the triple valves or the straight air brake valves are not in release position. The

remedy is evident and the trouble can be avoided by maintaining at least 10 or 20 pounds of excess pressure in the main reservoir when using the straight air, and keeping the straight air brake valve in release position when the automatic is in use.

If the straight air brake valve is left in lap position, when using the automatic brake, any leak of pressure by the double check will bank between the double check and the straight air brake valve. When the automatic is released, reducing the pressure in the brake cylinder a trifle below that on the straight air side of the double check, this pressure will force the double check over toward the automatic side, closing communication between the brake cylinder and the triple exhaust, thus holding the brake set, and the straight air valve must be placed in release position in order to release the brake.

If the automatic brake valve is left in full release position while using the straight air brake, the pressure of the main reservoir, brake pipe and auxiliary reservoirs will equalize, and in using the straight air, the main reservoir pressure will be reduced, which in turn will reduce the brake pipe pressure, causing the triple to assume set position. This high auxiliary pressure feeding to the automatic side of the double check will force the double check over toward the straight air release, and in releasing the straight air brake, the only pressure that can be released will be that which is between the straight air side of the double check and the straight air brake valve. In order to release the brake it will then be necessary to wait until the brake pipe pressure exceeds that in the auxiliary reservoir, by placing the automatic brake valve in lap position, which restores the excess pressure to a point where it will be sufficient to overcome the pressure in the auxiliary.

Drivers Sliding. If a bursted hose should cause an automatic application, or other conditions cause the driving wheels to slide, the driver brakes should be released at once by opening grade bleed cock D (Plate 50).

Wheel sliding to the extent of causing flat spots is inexcus-

able with the straight air. As the straight air pressure is 5 pounds lower than the automatic pressure, should be when fully applied, it reduces the liability of wheel sliding. When wheel sliding, due to slippery rails, does occur, the prompt release of the brakes, which is possible with straight air, will prevent damage to the wheels. While the straight air pressure can be adjusted below 45 pounds, there is no necessity for so doing, as it weakens the holding power. When the rails are bad and the speed is low the engineman should not use the full straight air pressure.

DEFECTS OF THE STRAIGHT AIR BRAKE.

When a blow occurs from the triple exhaust while the straight air brake valve is being used, it indicates a leak by the double check from the straight air to the automatic side.

If there is a blow at the straight air brake valve exhaust while using the automatic brake, it indicates that there is a leak by the double check from the automatic to the straight air side.

When there is a blow at the safety valve while the straight air is being used, it indicates that the tension of the spring is too weak, or that the reducing valve is not adjusted properly, or is held from its seat by dirt.

If there is a blow at the straight air exhaust while the straight air brake is in use, it indicates that the release valve of the straight air is held from its seat.

When there is a blow at the straight air exhaust when neither the automatic nor the straight air valve is in use, it indicates that application valve 8 of the straight air brake valve is held from its seat.

Locating Leaks. All of the leakages previously mentioned, any leakage in the pipes leading from the straight air brake valve to the brake cylinders, or leaks in the brake cylinders can be detected as follows:

When the pressure is fully pumped up, the number of strokes of the pump per minute required to maintain this pressure should

be noted. The straight air brake valve should then be placed in full application position and left until the pressure is again restored, when the pump strokes should again be counted. Any difference in the number of strokes will indicate the leakage at one or more of the places mentioned.

When the straight air brake valve is in application position, leakages can readily be located, as the straight air apparatus is constantly supplied with air from the main reservoir. The piston travel can also be accurately determined at the same time.

WESTINGHOUSE DUPLEX MAIN RESERVOIR CONTROL.

Plate 59 shows the general arrangement of the Westinghouse Duplex Main Reservoir Control. This arrangement differs from that which is usually found on a locomotive in the use of the duplex pump governor, in which one head is adjusted for low and one for high pressure.

The object of this arrangement is to permit the accumulation of a high main reservoir pressure, with which to release the brakes and recharge the auxiliary reservoirs, the pump being required to operate against the high pressure only during the time the brakes are applied. The head of the low pressure governor is usually adjusted at 90 pounds, and that of the high pressure at from 120 to 130 pounds.

Operation. The pump governor control is transferred from one head to the other by the movement of the brake valve handle. When the brake valve is in full release or running position the low pressure governor controls the pump, and when in lap, service or emergency position the high pressure governor controls the pump.

Plate 59, being a diagrammatic view of the method of piping, shows the manner in which the pump governor heads are coupled up. The high pressure head is coupled to the main reservoir connection of the brake valve, while the low pressure head is connected with port A, which leads to the running position

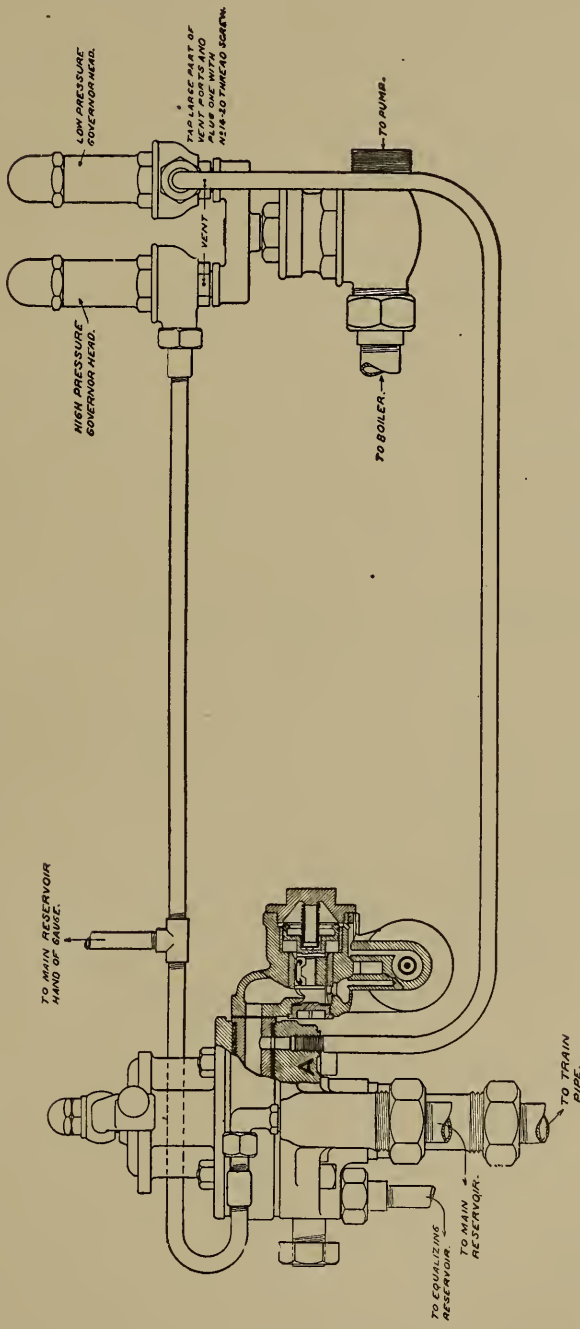


PLATE 59.

142 DOUBLE PRESSURE CONTROL OR SCHEDULE "U."

port f in the brake valve. The low pressure head is therefore subjected to main reservoir pressure when the brake valve is in running or release position, which allows the air pressure to pass to the low pressure head, causing the pump to stop when the main reservoir pressure is equal to the adjustment of this head. When the brake valve is placed in lap, service or emergency position, the main reservoir pressure is cut off from the feed valve and also from the low pressure governor head, and permits the pump to operate until the pressure in the main reservoir is equal to the adjustment of the high pressure head, which will then stop the pump.

While the brake valve is in running or release position port f is closed, but air pressure reaches the low pressure governor head by passing back from the brake pipe through the feed valve attachment.

DOUBLE PRESSURE CONTROL OR SCHEDULE "U."

The double pressure control equipment is shown on Plate 60. It consists of simple appliances, by means of which the engineer can change the brake pipe and main reservoir pressures from one predetermined standard to another.

This equipment is particularly adapted for use upon heavy grades, where "empties" are hauled up grades and "loads" down grades. A pressure of 70 pounds is carried in the brake pipe when the cars are empty, but this is increased to 90 pounds when the cars are loaded. Flat wheels would probably result if the higher pressure were carried with a train consisting of empty cars, but the higher braking power is so moderate in proportion to the total weights of cars and contents, when they are loaded, that danger of wheel sliding is practically eliminated.

The difference between the schedule "U" and the high speed brake equipment is as follows: No additional parts are used on the cars with schedule "U"; safety valves take the place of the reducing valves on the locomotive and tender equipment.

Operation. The operation of the double pressure control apparatus is very similar to that of the high speed brake equipment. When the reversing cock handle is in the position opposite to that shown on Plate 60, the 70-pound feed valve controls the brake pipe, and the entire apparatus will operate in the usual manner. A further description of the reversing cock and feed valve is given under the subhead "High Speed Brake." As the pump governor is piped in the same manner as with the ordinary equipment, the main reservoir pressure is cut off from acting upon the diaphragm of the pump governor when the brake valve is in lap, service and emergency application positions. While the main reservoir pressure is operative upon the excess pressure diaphragm when the brake valve is in release or running position, it is inoperative after the brakes have been applied and the brake valve returned to lap position, and the main reservoir pressure may then be pumped up to the limit established by the high pressure diaphragm. This high main reservoir pressure insures a prompt release and a quick recharging of the brakes upon a long train, and the pump operates against the high pressure only during the time the brakes are applied.

When a loaded train is about to descend a long, heavy grade, the handle of the reversing cock is turned to its opposite position, thus cutting out the low pressure feed valve. The brake pipe pressure is then controlled by the high pressure feed valve and the brakes are operated in the usual manner, but as the brake pipe and auxiliary reservoir pressures are now 90 pounds, a much more powerful brake application is available if desired.

The purpose of the safety valves connected with the driver and tender brake cylinders is to prevent the accumulation of a higher cylinder pressure than 50 pounds.

With a brake pipe pressure of 90 pounds upon freight trains, a reduction of about 25 pounds is necessary to cause the auxiliary reservoir and brake cylinder pressures to equalize with normal piston travel.

THE HIGH SPEED BRAKE.

The principles involved in the high speed brake are as follows :

(1) The friction between the brake shoes and the wheel, which tends to stop the rotation of the wheel, becomes less as the rapidity of the rotation of the wheel increases. (2) The adhesion between the wheel and the rail remains practically constant, regardless of the speed.

Plate 61 shows a modification of the quick action brake. The names of the parts, method of connection, and adjustment of the parts are indicated thereon.

The locomotive equipment shown on Plate 61 can be changed from the quick action to the high speed brake by turning the handle of the reversing cock. When this handle is in the position opposite to that shown on Plate 61, the 70-pound feed valve is in service. Seventy pounds pressure is carried in the brake pipe when the brake valve is in running position, and the pump will stop when the main reservoir pressure reaches 90 pounds. When the brake valve is in lap, service or emergency position, the main reservoir is cut off from the excess pressure diaphragm, and the air pump will continue to operate until the main reservoir pressure reaches the limit set by the maximum governor, which is generally from 120 to 130 pounds, thus insuring a prompt release and a quick recharging of the brakes on long trains.

At high speeds a greater brake cylinder pressure, with a corresponding increase in brake shoe pressure, can be used without danger of sliding wheels ; but in such cases it is also necessary to provide a means for reducing the high cylinder pressure, as the speed of the train is decreased. This is accomplished by means of the automatic reducing valve shown in the vertical cross section in Fig. 1, Plate 62. A horizontal cross section of this valve, through the point at which the connecting pipe to the brake cylinder is secured, is shown in Fig. 2, Plate 62. Plate 63 shows the application of the valve to a car. Plates 64, 65 and 66 are vertical cross sections of the upper part of the valve, showing the various positions of the slide valve.

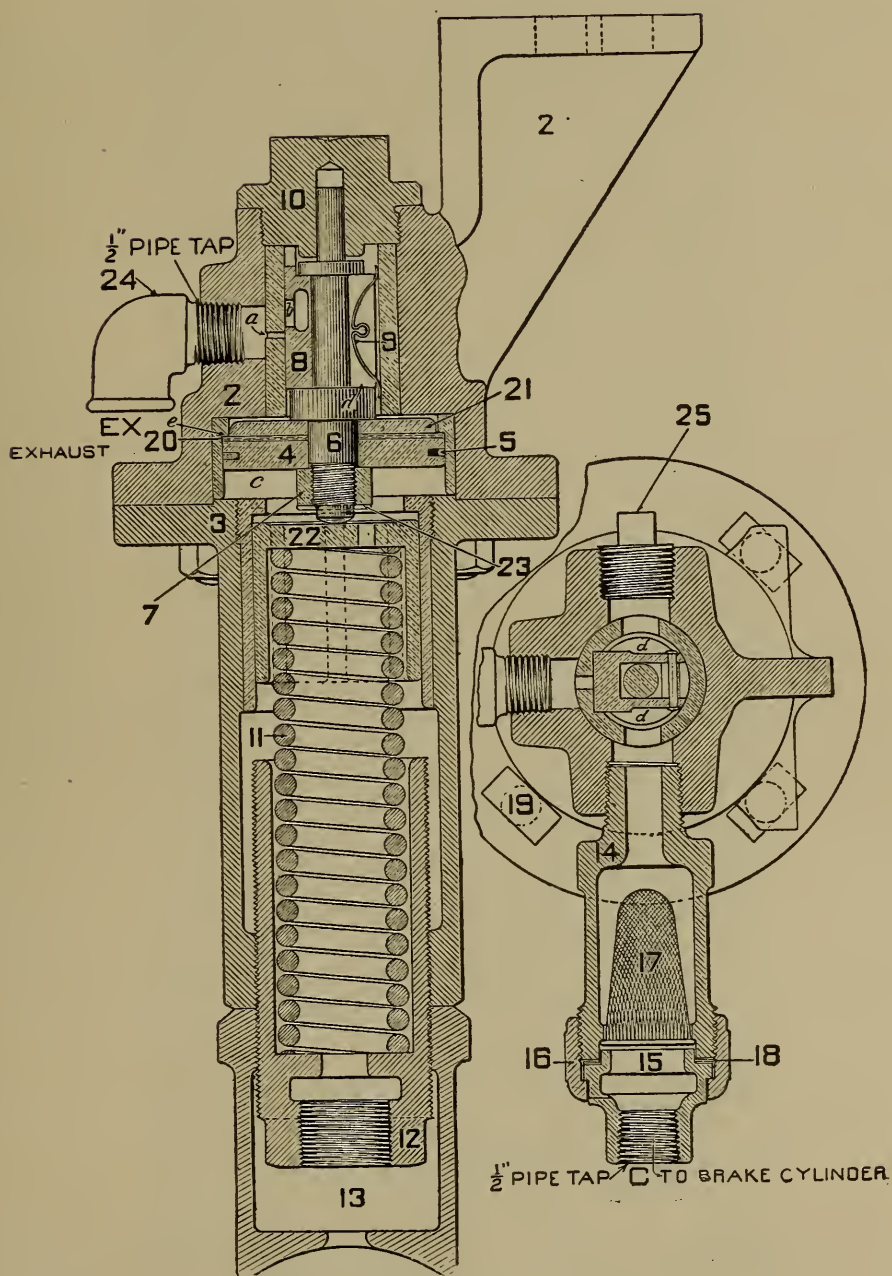


FIG. 1. PLATE 62. FIG. 2.

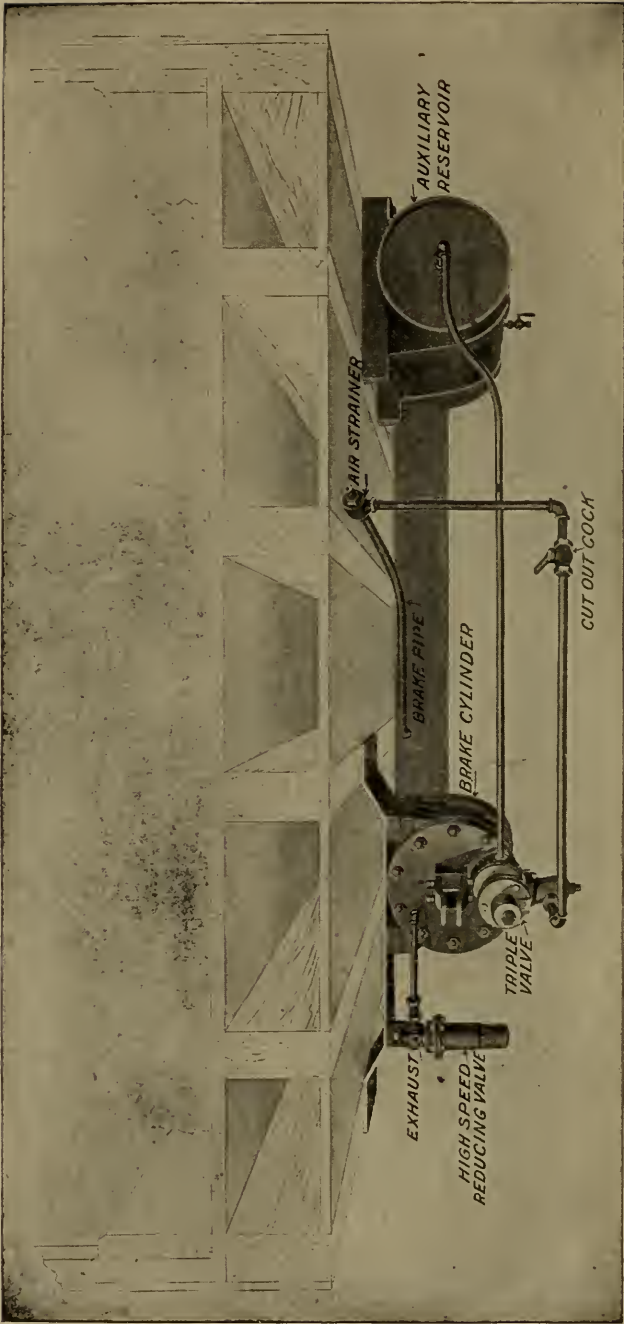


PLATE 63.

Reversing Cock. If the reversing cock handle is placed in the position shown, the 110-pound feed valve will become operative, giving a brake pipe pressure of 110 pounds, and a main reservoir pressure that will correspond with the adjustment of the maximum pressure head of the pump governor.

HIGH SPEED BRAKE REDUCING VALVE.

Operation. When air enters the brake cylinder from the auxiliary reservoir, it has free access to the reducing valve through a pipe connected at C (Fig. 2, Plate 62), so that chamber

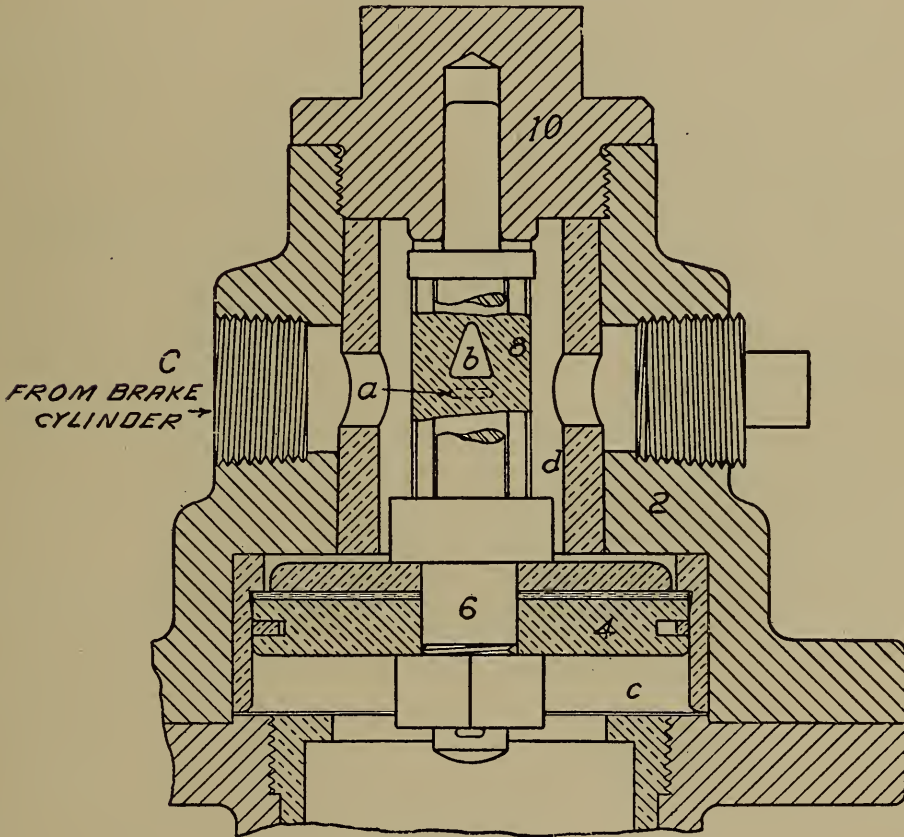


PLATE 64.

d, above piston 4, is always subject to brake cylinder pressure. Regulating spring 11, which is adjusted by means of nut 12, provides a resistance to the downward movement of piston 4, which

is finally arrested by spring box 3. Combined with piston 4 is its stem 6, fitted with two collars, which control the movement of slide valve 8. Slide valve 8 is provided with a triangular port *b* in its face, which is always in communication with chamber *d* (Plate 64). Port *a* in the slide valve seat leads directly to the atmosphere, through exhaust opening EX.

Slide valve 8 and its piston 4 are shown in their normal positions on Plate 64.

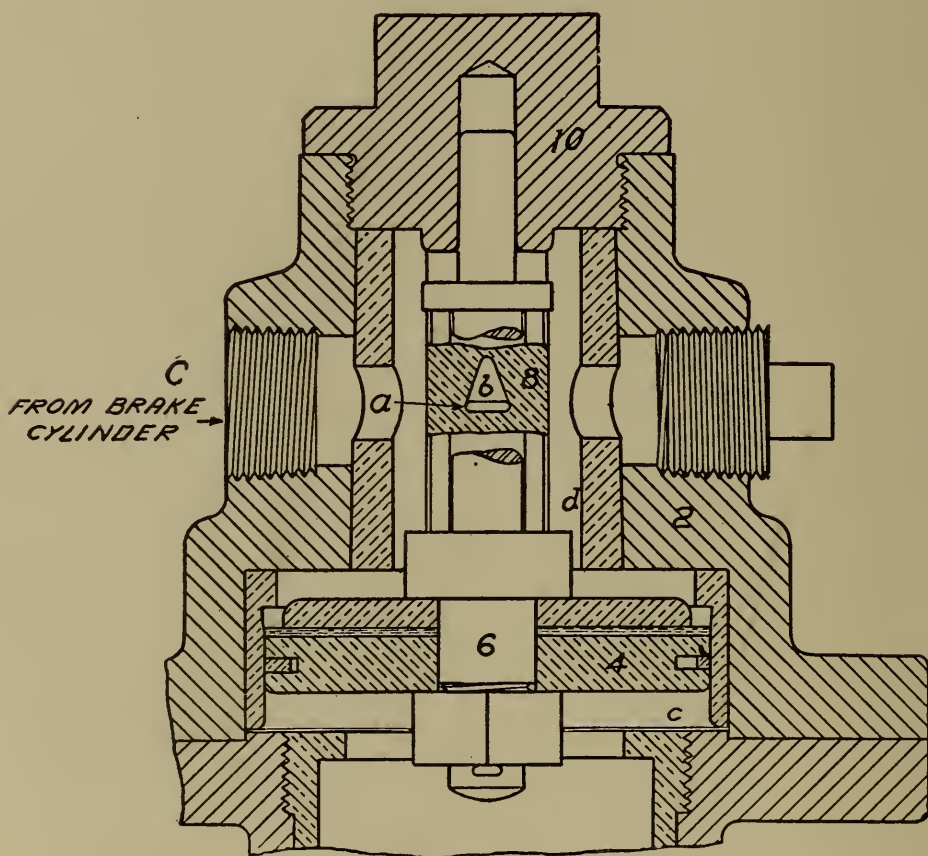


PLATE 65.

It will be noted that in release position port *b* of slide valve 8 does not register with port *a* of its seat, so that when the brakes are applied the air pressure is retained in the brake cylinder and is subsequently released in the usual way, unless it becomes suf-

ficiently high to overcome the tension of spring 11 and force piston 4 downward.

Service Application. When a heavy service application is made and the brake cylinder pressure exceeds 60 pounds, the pressure upon piston 4 moves it downward until port *b* in the

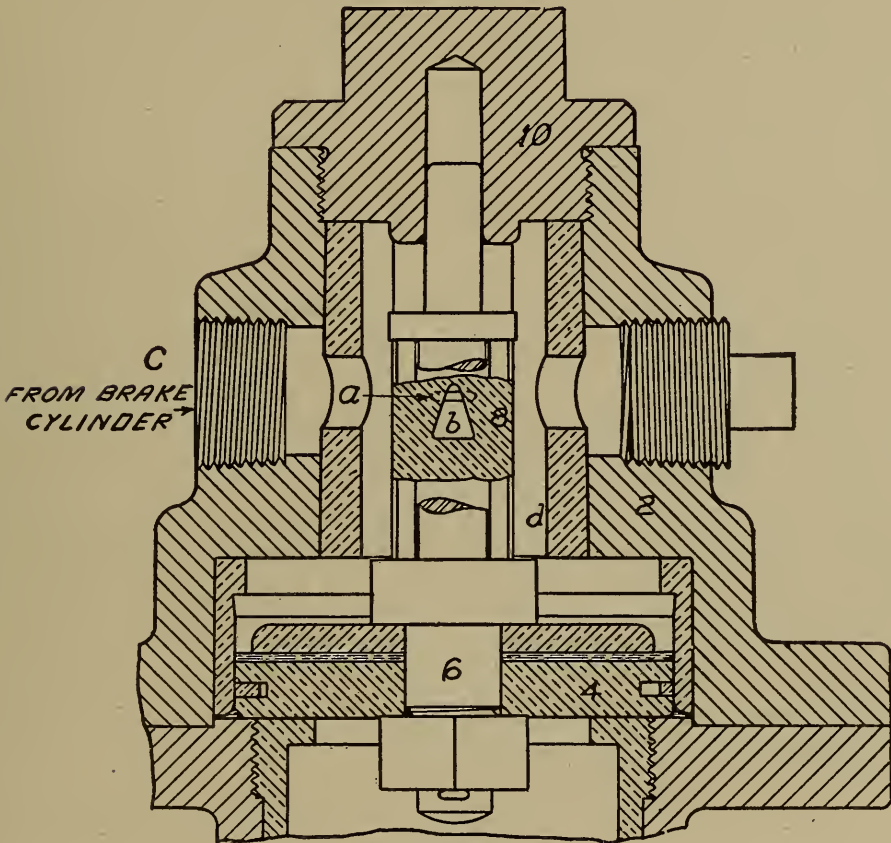


PLATE 66.

slide valve registers with port *a* in its seat (Plate 65), in which position any surplus brake cylinder pressure is promptly vented to the atmosphere. Spring 11 then raises the piston and the slide valve to their normal positions, closing the exhaust port and retaining 60 pounds pressure in the brake cylinder. In the operation just described, the greatest width of port *b* is exposed to port *a*, and these ports are so proportioned that, in this particular posi-

tion, the surplus air is discharged from the brake cylinder as rapidly as it is admitted through the service application port of the triple valve.

Emergency Application. The positions assumed by piston 4 and slide valve 8 in an emergency application of the brakes are shown on Plate 66. The violent admission of air into the brake cylinder suddenly increases the pressure on piston 4, forcing it to the lower end of its stroke, in which position the apex of triangular port *b* in the slide valve is brought into register with port *a*, and a comparatively slow discharge of brake cylinder pressure takes place while the train is at its highest speed; but the area of the opening of port *b* gradually increases as the decreasing pressure above piston 4 permits spring 11 to raise slowly the piston and slide valve. The rate of discharge thus increases as the speed of the train decreases. When the brake cylinder pressure has become reduced to 60 pounds port *a* is closed, and the remainder of the brake cylinder pressure is retained until it is released in the usual way through the triple.

When an emergency application of the brakes is made at high speeds, there is little danger of wheel sliding, and it will be observed that port *b* is so shaped that the brake cylinder pressure escapes slowly, while at lower speeds, where a heavy service application is more likely to occur and there is a greater tendency toward wheel sliding, the base of triangular port *b* is exposed, allowing the brake cylinder pressure to reduce quickly.

Brake Cylinder Pressure. With an emergency application, the auxiliary reservoir and brake cylinder pressures will momentarily equalize at 88 pounds, and a comparatively slow discharge of brake cylinder pressure will take place while the train is at its high speed.

The valve is so constructed that when piston 4 moves to its full stroke it is arrested by shoulder 3, thus permitting the valve to be constantly open from the brake cylinder to the atmosphere while the piston and slide valve are in downward position.

Inspection. Reducing valves should be inspected occa-

sionally, to prevent possible leaks through the discharge port, and to ascertain that the valve closes at the proper pressure.

Cars Not Equipped With Reducing Valves. Cars not equipped with the reducing valve should not be attached to trains employing the high speed brake, unless the brake cylinders are equipped with the safety valve provided for temporary use in such cases. The type "E" safety valve (Plate 58) has been especially designed to prevent a pressure greater than standard in the brake cylinders of cars not equipped with the reducing valve. The safety valve may be quickly screwed into the oil hole of the brake cylinder head, and removed when the cars are again placed in ordinary service.

Standard Pressures for High Speed Service. The standard pressures at which the different governors on the engine should be adjusted are as follows: The low pressure feed valve for the brake pipe, 70 pounds; the high pressure feed valve for the brake pipe, 110 pounds; the excess pressure head of the pump governor, 20 pounds differential; the maximum pressure head, 140 pounds.

Advantages of High Speed Pressure in Service Application. With the high speed brake it is possible to make two full service applications and releases without any prolonged effort to recharge, and still have 70 pounds of air in the auxiliary reservoirs with which to stop. A full service application here refers to a cylinder pressure of 50 pounds, as the auxiliary reservoirs are slightly recharged each time the brake valve is placed in full release position to release the brakes.

DEFECTS OF THE HIGH SPEED REDUCING VALVE.

A failure of the brakes to remain set may be caused by a cut slide valve or valve seat; a broken or improperly adjusted regulating spring; a worn out or defective packing ring 5, or packing leather 20, which would allow the air to pass down through the spring casing and out of the hole in the cap nut; or a leak in the pipe connection leading from the brake cylinder to the reducing valve.

GENERAL INFORMATION RELATING TO THE HIGH SPEED BRAKE.

When using the high speed brake it should be remembered that with a brake pipe pressure of 110 pounds, and the usual piston travel, a service brake pipe reduction of 5, 10 or 15 pounds will develop no more cylinder pressure than if the usual 70-pound brake pipe pressure were employed. If, however, when using a pressure of 110 pounds, the reduction is continued after the cylinder pressure has reached that at which the auxiliary reservoir and brake cylinder pressures equalize with the 70-pound brake pipe pressure, the cylinder pressure will increase until relieved by the reducing valve.

If the brake valve is placed in service position and allowed to remain there, the reducing valve, when it opens, will reduce the cylinder pressure about as fast as the triple valve can feed the air from the auxiliary reservoir to the brake cylinder. While the habit of making more than a 20 or 25-pound service reduction is not good practice, the feature just described goes to show that with a service reduction, the cylinder pressure will not rise materially above that at which the reducing valve is adjusted, which practically eliminates any possibility of wheel sliding under ordinary conditions.

The high speed brake was designed primarily to provide a means of stopping fast trains within a reasonable and safe distance, but it can also be used advantageously to save time in making service stops on local trains. To accomplish this result, when the speed of the train exceeds 30 miles per hour, a heavy initial reduction of from 12 to 15 pounds should be made, and when the speed of the train is reduced to from 15 to 18 miles per hour a release should be made to exhaust the high cylinder pressure and allow the trucks to regain their equilibrium. A light reduction will then stop the train without any attendant disagreeable shock. This method of using the air is not only productive of quick stops, but it reduces the liability of wheel sliding to a minimum, as the low cylinder pressure is coincident with slow speed.

THE REVERSING COCK.

This device is a combination of a two-way cock with a bracket, to which are fastened the two slide valve feed valves required.

Its design and appearance are shown on Plate 67. The two pipe tapped openings in the back are connected by piping with the corresponding openings of the pipe bracket on the engineer's brake valve (Plate 67). The opening marked "from main reservoir" connects with the feed port, which admits main reservoir pressure to the feed valves when the brake valve is in running position, and the opening marked "to brake pipe" connects with the brake valve port from the feed valve to the brake pipe.

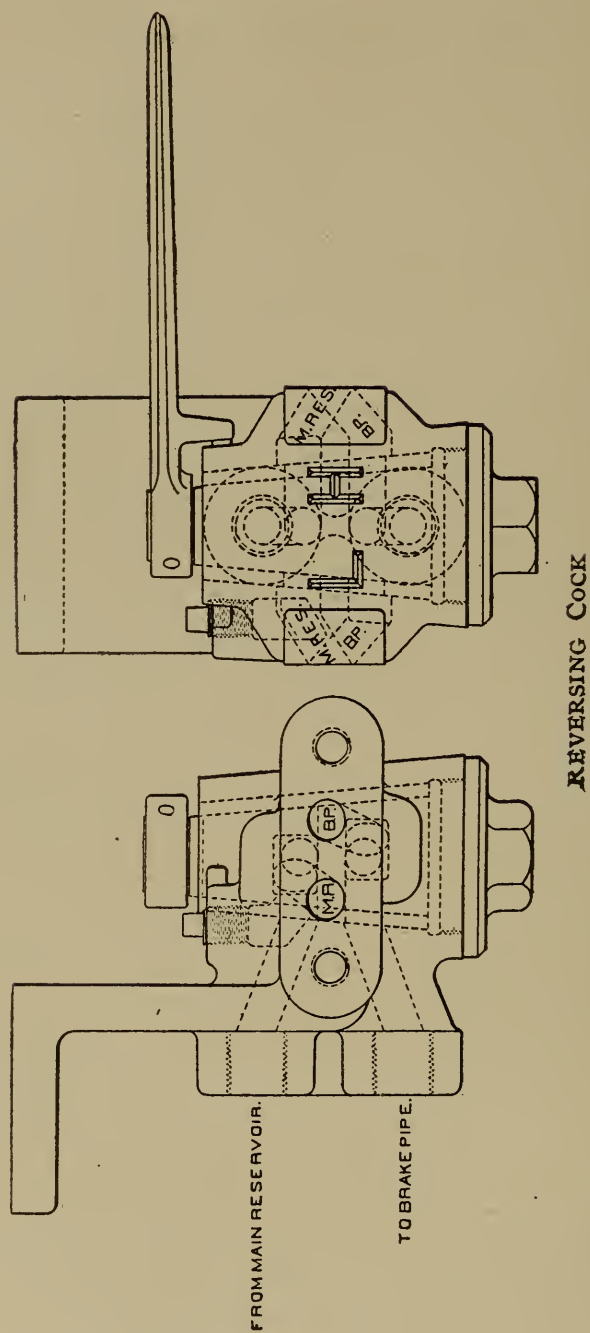
Operation. At all times when the brake valve is in running position, main reservoir pressure is admitted to the upper passage in the reversing cock, and thence through the top port in the cock plug to the openings in the flange on either one side or the other, which connects with the opening in the high pressure side of the slide valve feed valve.

After passing through the feed valve, the reduced air pressure enters the reversing cock at the opening BP, and, passing through the lower passages in the reversing cock, is brought by the piping and port in the brake valve to the brake pipe.

In this way the pressure in the brake pipe is determined by one of the two feed valves which is brought into operation through the position of the reversing cock handle.

The small pipe tapped opening in the top of the reversing cock (shown in the cut as plugged) is only for use with the SD-4 (old standard) type of Duplex Pump Governor, and, when this governor is used, it is connected with its low pressure diaphragm. It will be seen that the main reservoir pressure communicates with this opening only when the cock handle is turned towards the low pressure side marked "L" in front. In this way the low pressure governor head is cut out during the lap, service and emergency positions of the brake valve, and when the reversing cock handle is in the high pressure position.

REVERSING COCK.



Plates 68 and 69 illustrate the device known as the slide valve feed valve, which is used to reduce main reservoir pressure to a predetermined brake pipe pressure, when the brake valve is in running position. One of these valves is attached to each side of

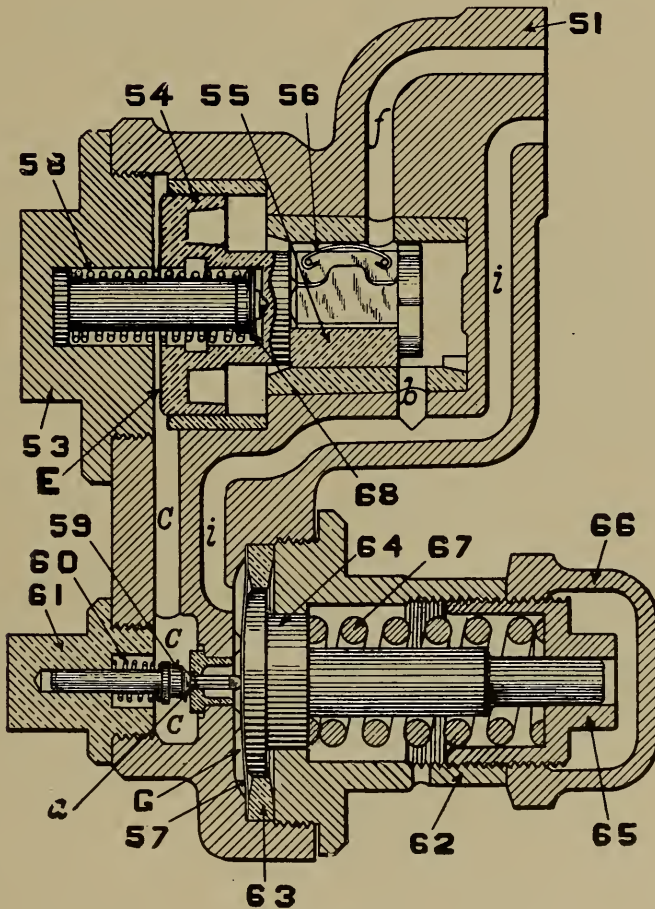


PLATE 68.

the reversing cock, and its operation is fully illustrated and described on Pages 58 to 62.

Adjustment. The regulating spring 67 is generally adjusted to maintain a pressure of 70 pounds in the brake pipe by the low pressure feed valve, and 110 pounds by the high pressure feed valve. The details of both feed valves are identical.

The defects of the slide valve feed valve are similar to those used on the G-6 brake valve.

If either of the pipes leading to the feed valve becomes broken it would be necessary to remove the pipe bracket from the brake

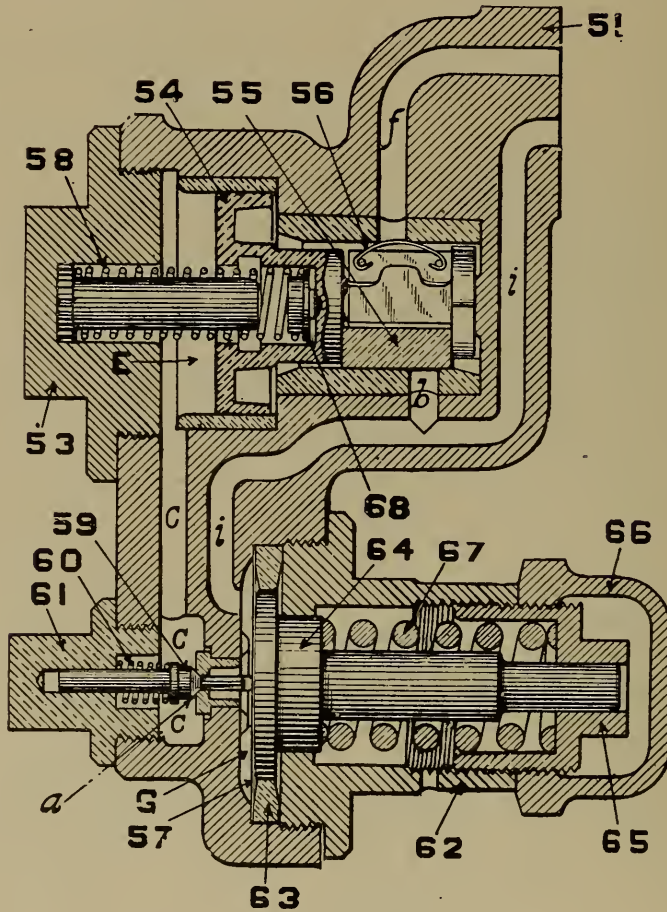


PLATE 69.

valve, and connect the feed valve with the brake valve, which would allow the same pressure to be used as before.

THE NO. 6 ET LOCOMOTIVE BRAKE EQUIPMENT.

The new locomotive brake equipment here illustrated and described is known as the ET (engine and tender) brake equipment. It differs materially from the present combined automatic and straight air brake in that it consists of considerably less apparatus. In operation it possesses all the advantages of the latter type of brake equipment, and in addition several other important ones which are necessary in modern locomotive brake service.

The design of the principal valves comprising the ET equipment is such that it may be applied to any locomotive, whether in high speed passenger, double pressure control, ordinary passenger or freight, or any kind of switching service, without change or special adjustment of the brake apparatus. All valves are so designed that they may be removed for repairs and replaced without disturbing the pipe joints.

In operation its important advantages are, that the locomotive brakes may be used with or independently of the train brakes, without regard to the position of the locomotive in the train; the brakes can be applied with any desired pressure between the maximum and the minimum, and this pressure will be automatically maintained in the locomotive brake cylinders, regardless of leakage from them and of variation in piston travel, until released by the brake valve. They can be graduated on or off with either the automatic or the independent brake valve; hence, in all kinds of service the train can be handled without shock or danger of parting, and in passenger service smooth, accurate stops can be made with greater ease than has heretofore been possible.

MANIPULATION.

The instructions relating to its use are general and must be supplemented to a limited extent to meet fully the varying local conditions on different railways.

The manipulation of the ET equipment is practically the same as the combined automatic and straight air brake; therefore, no radical departure from present methods of air brake practice is required to get the desired results.

Positions of Brake Valve Handles. When not in use, the handles of both brake valves should be carried in running position. To make a service application, move the handle of the automatic brake valve to service position until the required brake pipe reduction has been made, when it should be moved to lap position, which is the one for holding the brakes applied.

To release the train brakes, move the handle to release position and leave it there until all the triple valves are in release position. If the locomotive brakes are to be released at once the handle should be moved to running position, but if they are to be held for a time it should be moved to holding position and the brakes graduated off by short, successive movements between running and holding positions. With all freight trains, especially long ones, the brake valve must be left in both release and holding positions very much longer than with short trains, particularly passenger trains.

To apply the brakes in an emergency application, move the handle of the automatic brake valve quickly to emergency position and leave it there until the train is stopped or the danger is past.

To make a smooth and accurate two-application passenger train stop, the first application should be heavy enough to reduce the speed of the train to about 15 miles per hour at a convenient distance from the stopping point; the train brakes should then be released by moving the handle to release position, and then the locomotive brakes by moving the handle to running position for two or three seconds before making a second application.

When using the independent brake only, the handle of the automatic brake valve should be carried in running position. An independent application may be released by moving the independent brake valve to running position. Release position is for use only when the automatic brake valve is not in running position.

Handling Long Trains. While handling long trains in road or switching service the independent brake should be operated with care to prevent damage to cars and lading, caused by running the slack in or out too hard. In cases of emergency arising while the independent brake is applied, the automatic brake should be applied instantly. The safety valve will restrict the brake cylinder pressure to the proper maximum.

Alternating Engine and Train Brakes. The brakes on the locomotive and on the train should be alternated in heavy grade service to prevent overheating of driving wheel tires and to assist the pressure retaining valves in holding the train while the auxiliary reservoirs are being recharged. This is done by keeping the locomotive brakes released by use of the independent brake valve when the train brakes are applied, and applying the locomotive brakes just before the train brakes are released, and then releasing the locomotive brakes after the train brakes are re-applied.

Releasing Engine Brakes. When all brakes are applied automatically, to graduate off or entirely release the locomotive brakes only, the independent brake valve should be used in release position.

Release position of the independent brake valve will release the locomotive brakes under any and all conditions.

Engine Brake Cylinder Pressure. The red hand of the air gauge (Plate 71) will show at all times the pressure in the locomotive brake cylinders, and this hand should be closely observed in brake manipulation.

Releasing Train Brakes Before Detaching Locomotive. The train brakes should always be released before detaching the locomotive, and the train held with the hand brakes when necessary. This is especially important on grades, as there is otherwise no assurance that the car, cars or train so detached will not start when the air brakes leak off, as is possible where there is considerable leakage.

The automatic brakes should never be used to hold a standing

locomotive or a train, even when the locomotive is not detached, for a longer time than ten minutes, and not for such time if the grade is very steep or the condition of the brakes is not up to standard. The safest method is to hold the train with the hand brakes only and to keep the auxiliary reservoirs fully charged, in order to guard against a start caused by the brakes leaking off. By doing this, it is possible to obtain any part of the full braking power immediately after starting.

The Independent Brake. The independent brake is a very important safety feature in this connection, as it will hold a locomotive with a leaky throttle, or quite a heavy train, on a fairly steep grade, if, as the automatic brakes are released, the slack is prevented from running in or out (depending on the tendency of the grade) and giving the locomotive a start. The best method of making a stop on a descending grade is to apply the independent brake heavily as the stop is being completed, thus bunching the train solidly. Then, when the train is stopped, the independent brake valve should be placed and left in application position, and the automatic brakes released and then recharged. If the independent brakes are unable to prevent the train from starting, the automatic brakes will have become sufficiently recharged to make an immediate stop. In such an event, enough hand brakes should be applied at once as are necessary to assist the independent brakes to hold the train. Many runaways and some serious wrecks have resulted through failure to comply with the foregoing instructions.

When leaving the engine or while doing work about it, or when it is standing at a coal chute or water plug, the independent brake valve should always be left in application position.

In case the automatic brakes are applied by a bursted hose, a break-in-two, or the use of the conductor's valve, the automatic brake valve must be placed in lap position.

When there are two or more locomotives in a train the double-heading cock must be closed, and the handle of the automatic brake valve carried in running position on each engine,

except the one from which the brakes are being operated.

Before leaving the roundhouse the engineman should try the brakes with both brake valves, and should see that no serious leaks exist. The pipes between the distributing valve and the brake valves must be absolutely tight.

PARTS OF EQUIPMENT.

1. The air pump, for the purpose of compressing the air.
2. The main reservoirs, in which to store and cool the air, and collect water and dirt.
3. A duplex pump governor, for controlling the pump when the pressures are attained for which it is regulated.
4. A distributing valve, and small double chamber reservoir to which it is attached, which are placed on the locomotive to perform the functions of triple valves, auxiliary reservoirs, double check valves, high speed reducing valves, etc.
5. Two brake valves, the automatic to operate the locomotive and train brakes, and the independent to operate the locomotive brakes only.
6. A feed valve, to regulate the brake pipe pressure.
7. A reducing valve, to reduce the pressure for the independent brake valve and for the air signal system when used.
8. Two duplex air gauges, one to indicate the equalizing reservoir and main reservoir pressures, the other to indicate the brake pipe and locomotive brake cylinder pressures.
9. Driver, tender and truck brake cylinders, cut-out cocks, air strainers, hose couplings, fittings, etc., incidental to the piping, for purposes of brake operation.

NAMES OF PIPING.

Discharge Pipe: Connects the Air Pump to the first Main Reservoir.

Connecting Pipe: Connects the two Main Reservoirs.

Main Reservoir Pipe: Connects the second Main Reservoir

to the Automatic Brake Valve, Distributing Valve, Feed Valve, Reducing Valve, and Pump Governor.

Feed Valve Pipe: Connects the Feed Valve to the Automatic Brake Valve.

Excess Pressure Governor Pipe: Connects the Feed Valve Pipe to the Excess Pressure Head of the Pump Governor.

Reducing Valve Pipe: Connects the Reducing Valve to the Independent Brake Valve, and also the Signal System when used.

Brake Pipe: Connects the Automatic Brake Valve with the Distributing Valve and all Triple Valves on the cars in the train.

Brake Cylinder Pipe: Connects the Distributing Valve with the Driver, Tender and Truck Brake Cylinders.

Application Cylinder Pipe: Connects the Application Cylinder of the Distributing Valve to the Independent and Automatic Brake Valves.

Distributing Valve Release Pipe: Connects the Application Cylinder Exhaust Port of the Distributing Valve to the Automatic Brake Valve through the Independent Brake Valve.

ARRANGEMENT OF APPARATUS.

Plate 70 is a diagram of the No. 6 ET equipment, giving the necessary instructions for making the correct pipe connections for the equipment. Plate 71 is a similar diagram giving the designations of the apparatus and piping as referred to in the following description:

Referring to Plate 71, air after being compressed by the pump passes to the main reservoirs and the main reservoir pipe. The main reservoir cut-out cock is for the purpose of cutting off and venting the air from the main reservoir pipe, when removing any of the apparatus, except the governor. The end toward the main reservoir is tapped for a connection to the pump governor. Before this cock is closed the double-heading cock should be closed, and the brake valve handle placed in release position. This is to prevent the slide valve of the feed valve, and the rotary valve of the brake valve, from being lifted from their seats.

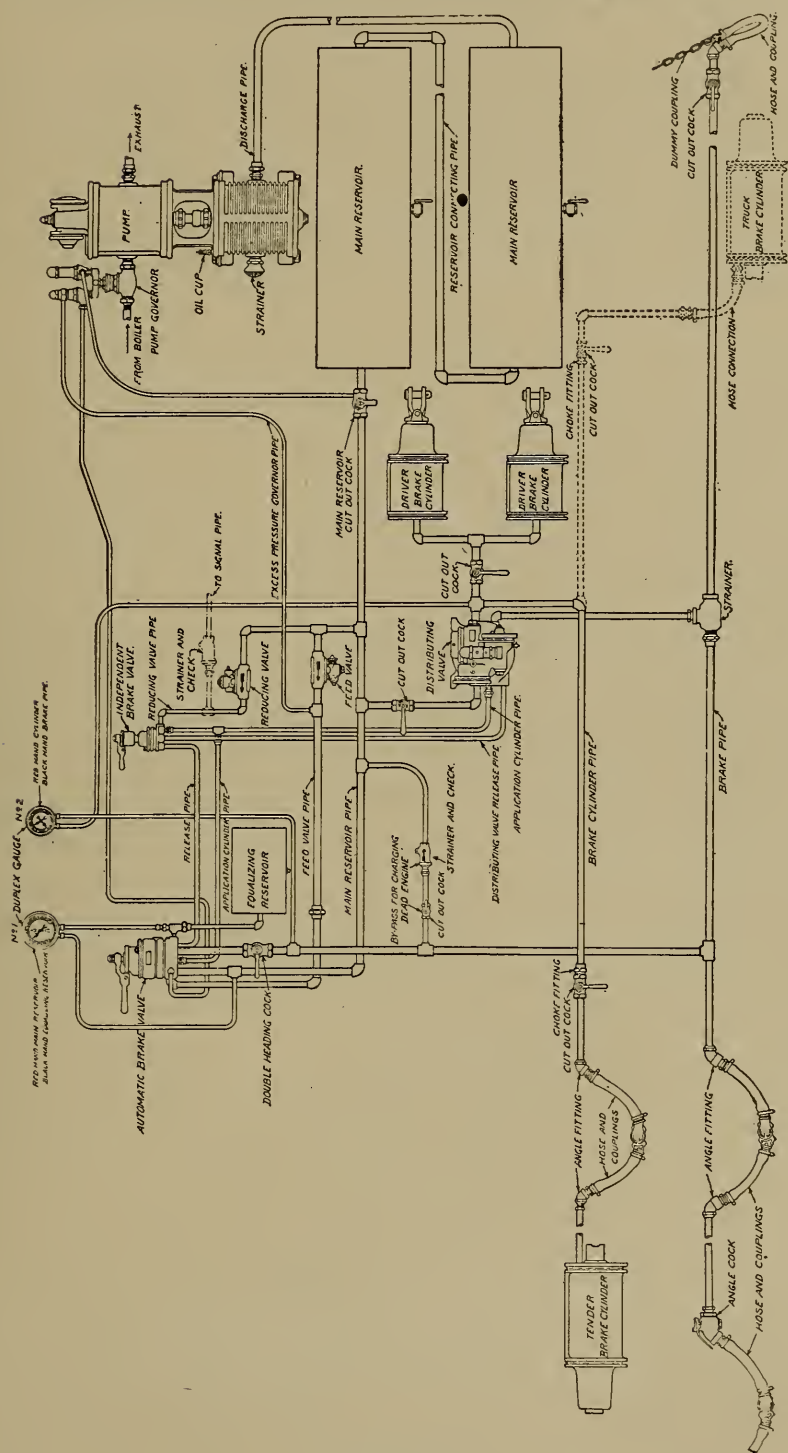


PLATE 70.

Main Reservoir Connections. Beyond the main reservoir cut-out cock the main reservoir pipe has four branches, one of which runs to the automatic brake valve, one to the feed valve, one to the reducing valve, and one to the distributing valve. As a result, the automatic brake valve receives air from the main reservoirs in two ways, one direct and the other through the feed valve.

The feed valve pipe leading from the feed valve to the automatic brake valve has a branch on top of the excess pressure head of the duplex pump governor.

The third branch of the main reservoir pipe connects with the reducing valve. Air at the pressure for which this valve is set (45 pounds) is supplied to the independent brake valve through the reducing valve pipe.

Air Signal Connections. When the air signal system is installed it is connected to the reducing valve pipe, in which case the reducing valve also takes the place of the signal reducing valve formerly employed. In the branch pipe supplying the air signal system is placed a combined strainer, check valve and choke fitting. The strainer prevents any dirt from reaching the check valve and choke fitting. The check valve prevents air from flowing back from the signal pipe when the independent brake is applied. The choke fitting prevents the reducing valve from raising the signal pipe pressure so quickly as to prevent the operation of the signal system.

Distributing Valve Connections. The distributing valve has five pipe connections made through the end of the double chamber reservoir, three to the left and two to the right. Of the three on the left, the upper is the supply pipe, leading from the main reservoir; the intermediate is the application cylinder pipe, leading to the independent and automatic brake valves, and the lower is the distributing valve release pipe, leading through the independent brake valve to the automatic brake valve, when the handle of the independent brake valve is in running position. Of the two on the right, the lower is the brake pipe branch connec-

tion, and the upper is the brake cylinder pipe, branching to all brake cylinders on the engine and tender. In this pipe are placed cocks for cutting out the brake cylinders when necessary, and in the engine truck and tender brake cylinder cut-out cocks are placed choke fittings to prevent serious loss of main reservoir air, and the release of the other locomotive brakes during a stop, in case of a bursted brake cylinder hose.

The automatic brake valve connections, other than those already mentioned, are the brake pipe, the main reservoir, the equalizing reservoir, and the lower connection to the excess pressure head of the pump governor.

PRINCIPLES OF OPERATION.

The principles governing the operation of the ET equipment are similar to those of other styles of equipment. The difference consists in the means for supplying the air pressure to the brake cylinders. Instead of a triple valve and auxiliary reservoir for each of the engine and tender equipments, the distributing valve supplies all brake cylinders. The distributing valve consists of two portions, known as the equalizing portion and the application portion. It is connected with a double chamber reservoir, the two chambers of which are called respectively the pressure and the application chambers. The latter is ordinarily connected with the application portion of the distributing valve in such a way as to enlarge the volume of that part of it called the application cylinder (Plate 72). The connections between these parts, as well as their operation, may be compared with that of a miniature brake set, the equalizing portion representing the triple valve, the pressure chamber the auxiliary reservoir, and the application portion always having practically the same pressure in its cylinder as that in the brake cylinders. This is shown by the diagrammatic illustration on Plate 72. For convenience, compactness and security they are combined in one device, as shown on Plates 73 and 74. The equalizing portion and pressure chamber are used in automatic applications only. Reductions of

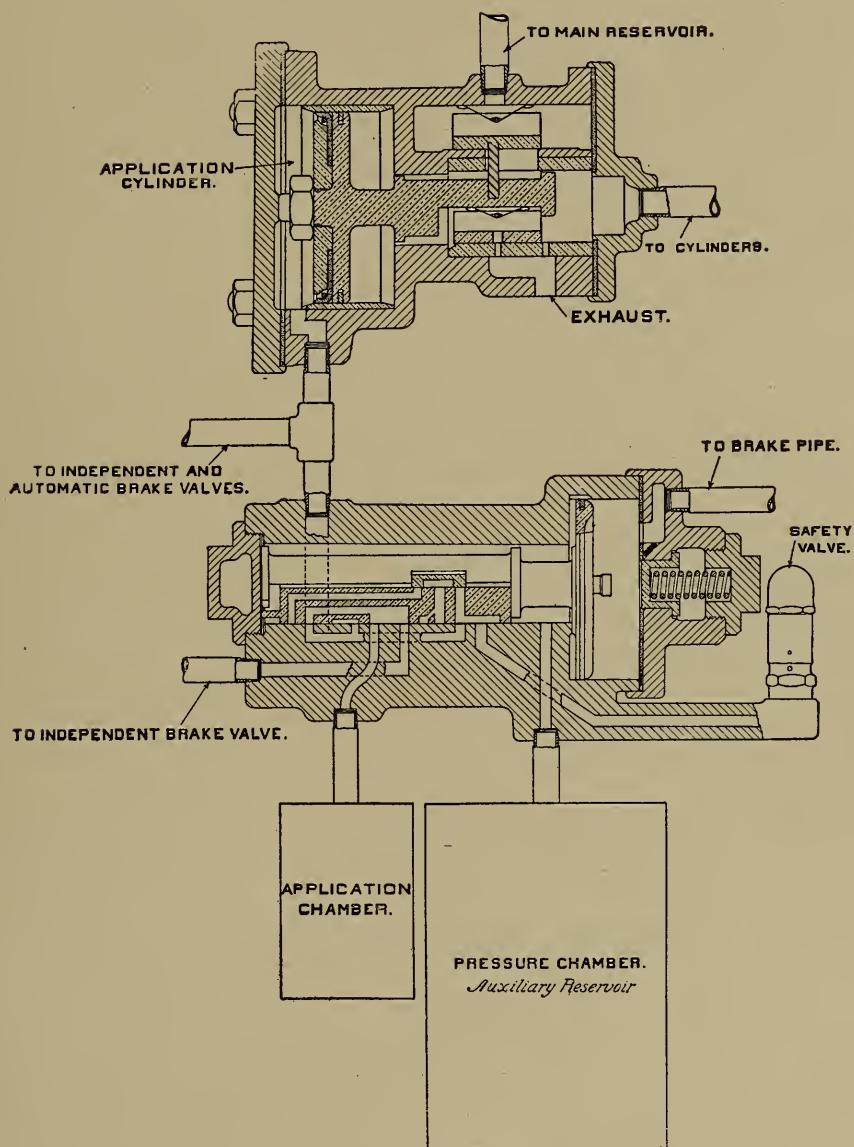


PLATE 72.

brake pipe pressure cause the equalizing valve to connect the pressure chamber to the application cylinder, allowing air to flow from the former to the latter. The upper slide valve connected to the piston rod of the application portion admits air to the brake cylinders and is called the application valve, while the lower one releases the air from the brake cylinders and is called the exhaust valve. As the air admitted to the brake cylinders comes directly from the main reservoirs, the supply is practically unlimited. Any pressure in the application cylinder will force the application piston to close the exhaust valve, open the application valve and admit air from the main reservoirs to the locomotive brake cylinders until their pressure equals that in the application cylinder. Also any variation of application cylinder pressure will be duplicated in the locomotive brake cylinders and the resulting pressure maintained, regardless of any brake cylinder leakage. The whole operation of this locomotive brake, therefore, consists in admitting and releasing air into or out of the application cylinder; in independent applications, directly through the independent brake valve, and in automatic applications, by means of the equalizing portion and the air pressure stored in the pressure chamber.

The well-known principle embodied in the quick action triple valve, by which a high braking power is obtained in emergency applications, and a sufficiently lower one in full service applications, to provide against wheel sliding, is also embodied in the No. 6 distributing valve. This is accomplished by cutting off the application chamber from the application cylinder in all emergency applications. In emergency applications the pressure chamber fills the small space of the application cylinder only, thus giving a high equalization and a correspondingly high brake cylinder pressure. In service applications it must fill the same volume combined with that of the application chamber, thus giving a lower equalization and a correspondingly lower brake cylinder pressure.

THE No. 6 DISTRIBUTING VALVE.

This valve is an important feature of the ET equipment. Plate 73 shows the two chambers of the reservoirs. Safety valve 34 is also an essential part of the distributing valve, and is shown on Plate 86.

List of Parts. Referring to Plates 73 and 74, the names of the different parts of this apparatus are as follows:

- | | |
|---|--|
| 2. Body. | 26. Equalizing Piston. |
| 3. Application Valve Cover. | 27. Equalizing Piston Packing Ring. |
| 4. Cover Screw. | 28. Graduating Valve. |
| 5. Application Valve. | 29. Graduating Valve Spring. |
| 6. Application Valve Spring. | 31. Equalizing Valve. |
| 7. Application Cylinder Cover. | 32. Equalizing Valve Spring. |
| 8. Cylinder Cover Bolt and Nut. | 33. Lower Cap Nut. |
| 9. Cylinder Cover Gasket. | 34. Safety Valve. |
| 10. Application Piston. | 35. Double Chamber Reservoir. |
| 11. Piston Follower. | 36. Reservoir Stud and Nut. |
| 12. Packing Leather Expander. | 37. Reservoir Drain Plug. |
| 13. Packing Leather. | 38. Distributing Valve Drain Cock. |
| 14. Application Piston Nut. | 39. Application Valve Cover Gasket. |
| 15. Application Piston Packing Ring. | 40. Application Piston Cotter. |
| 16. Exhaust Valve. | 41. Distributing Valve Gasket (not shown). |
| 17. Exhaust Valve Spring. | 42. Oil Plug. |
| 18. Application Valve Pin. | 43. Safety Valve Air Strainer. |
| 19. Application Piston Graduating Stem. | 44. Equalizing Piston Graduating Sleeve. |
| 20. Application Piston Graduating Spring. | 45. Equalizing Piston Graduating Spring Nut. |
| 21. Graduating Stem Nut. | 46. Equalizing Piston Graduating Spring. |
| 22. Upper Cap Nut. | |
| 23. Equalizing Cylinder Cap. | |
| 24. Cylinder Cap Bolt and Nut. | |
| 25. Cylinder Cap Gasket. | |



PLATE 73.

Tracing of Ports and Connections. To simplify the tracing of the ports and connections, the various positions of this valve are illustrated in nine diagrammatic views; that is, the valve is distorted to show the parts differently than actually constructed, with the object of explaining the operation clearly instead of showing the exact design of the parts. The chambers of the reservoir are, for convenience, indicated at the bottom as a portion of the valve itself. On Plate 74 equalizing piston 26, graduating valve 28, and equalizing slide valve 31, are shown as actually constructed. But, as there are ports in the valves which cannot thus be clearly indicated, the diagrammatic illustrations show each slide valve considerably elongated, so as to make all the ports appear on one plane, with similar treatment of the equalizing valve seat. Plate 75 shows the correct location of these ports.

Main Reservoir Pressures. Referring to Plate 76, it will be seen that main reservoir pressure is always present in the chamber surrounding application valve 5, by its connection through passage *a, a*, to the main reservoir pipe. Chamber *b* to the right of application piston 10 is always in free communication with the brake cylinders, through passage *c* and the brake cylinder pipe. Application cylinder *g* at the left of application piston 10 is connected by passage *h* with the equalizing valve seat, and to the brake valves through the application cylinder pipe.

AUTOMATIC OPERATION.

Charging. Referring to Plate 76, which shows the movable parts of the valve in release position, it will be seen that as chamber *p* is connected with the brake pipe, brake pipe air flows through feed groove *v* around the top of piston 26 into the chamber above equalizing valve 31, and through port *o* to the pressure chamber until the pressures on both sides of the piston are equal.

Service Application. When a service application is made with the automatic brake valve, the brake pipe pressure in chamber *p* is reduced, causing a difference in pressures on two sides

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of this piston, which results in the piston moving toward the right. The first movement of the piston closes the feed groove and at the same time moves the graduating valve until it uncovers the upper end of port *s* in the equalizing valve 31. As the piston

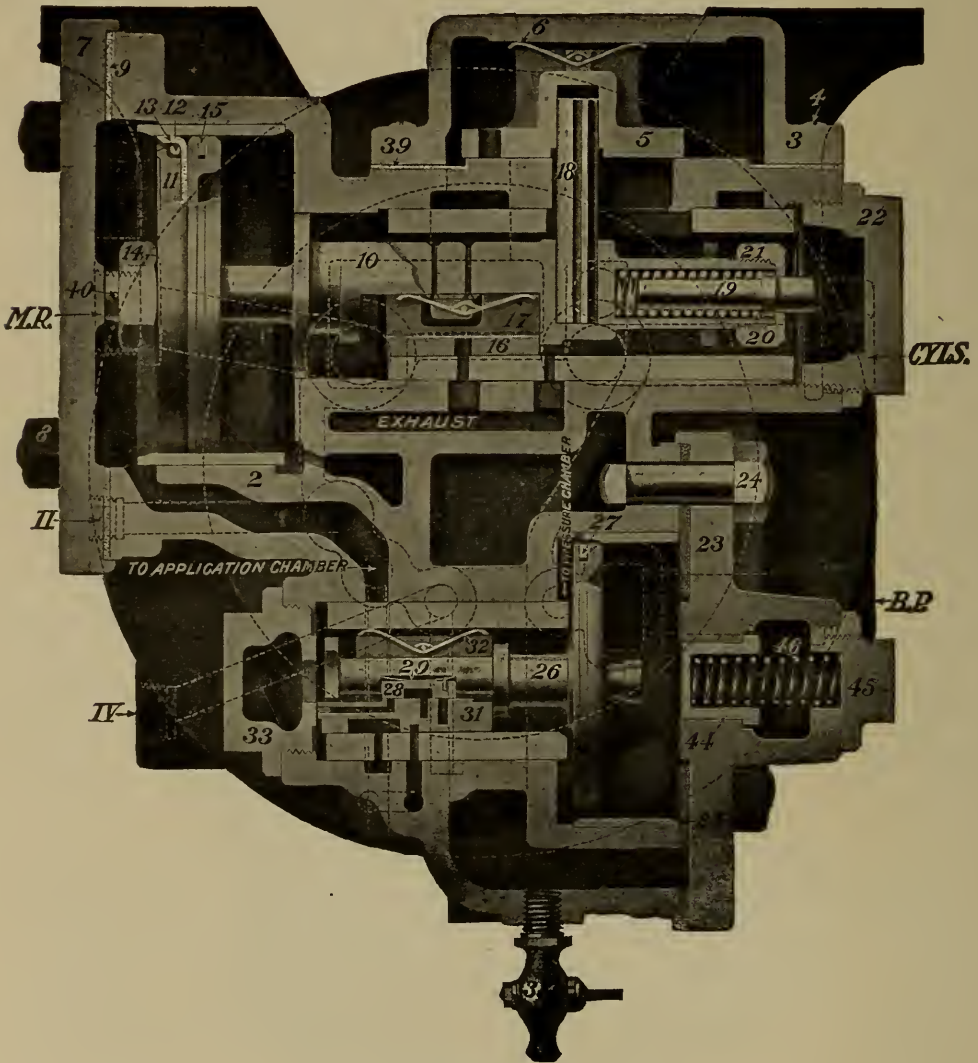
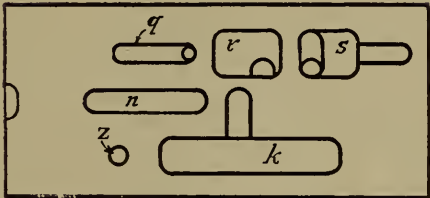


PLATE 74.

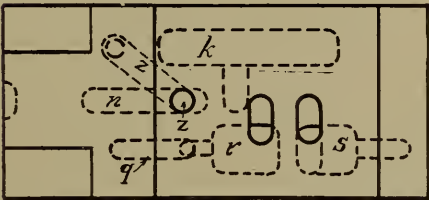
continues its movement the shoulder on the end of its stem engages the equalizing valve, which is then also moved to the right until the piston strikes equalizing piston graduating sleeve 44,



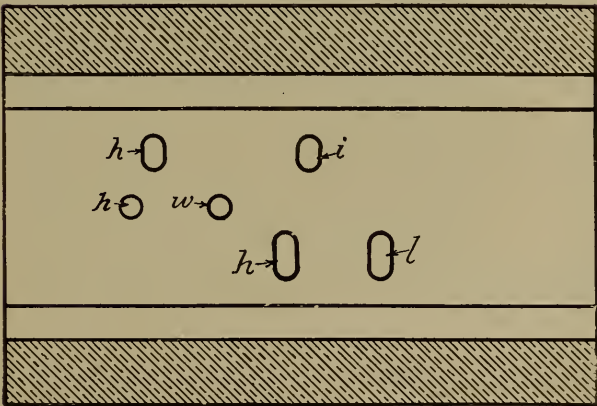
PLAN OF
GRADUATING VALVE.



FACE OF SLIDE VALVE.



PLAN OF SLIDE VALVE.



PLAN OF SLIDE VALVE SEAT.
PLATE 75.

graduating spring 46 preventing further movement; port *s* in the equalizing valve then registers with port *h* in the seat, and cavity *n* in the equalizing valve connects ports *h* and *w* in the seat. As the equalizing valve chamber is always in communication with the pressure chamber, air can now flow from the latter to both the application cylinder and the application chamber. This pressure forces application piston 10 to the right, as shown on Plate 77, causing exhaust valve 16 to close exhaust ports *e* and *d*, and to compress application piston graduating spring 20, and also causing application valve 5, by its connection with the piston stem through pin 18, to open its ports and allow air from the main reservoirs to flow into chambers *b, b*, and through passage *c* to the brake cylinders.

During the movement just described, cavity *t* in the graduating valve connects ports *r* and *s* in the equalizing valve, and by the same movement ports *r* and *s* are brought into register with ports *h* and *l* in the seat, thus establishing communication from the application cylinder to the safety valve, which is set at 68 pounds, 3 pounds above the maximum obtained in an emergency application from a 70-pound brake pipe pressure, thus limiting the brake cylinder pressure to this amount.

The amount of pressure resulting in the application cylinder with a certain brake pipe service reduction depends on the comparative volumes of the pressure chamber, application cylinder and its chamber. These volumes are such that if they are allowed to remain connected by the ports in the equalizing valve, with 70 pounds in the pressure chamber and nothing in the application cylinder and chamber, they will equalize at a pressure of about 50 pounds.

Service Lap. When the brake pipe reduction is not sufficient to cause a full service application, the conditions described above continue until the pressure in the pressure chamber is reduced sufficiently below that in the brake pipe to cause piston 26 to force graduating valve 28 to the left until stopped by the shoulder on the piston stem striking the right-hand end of equal-

izing valve 31, the position indicated on Plate 78, and known as service lap. In this position, graduating valve 28 has closed port *z* so that no more air can flow from the pressure chamber to the

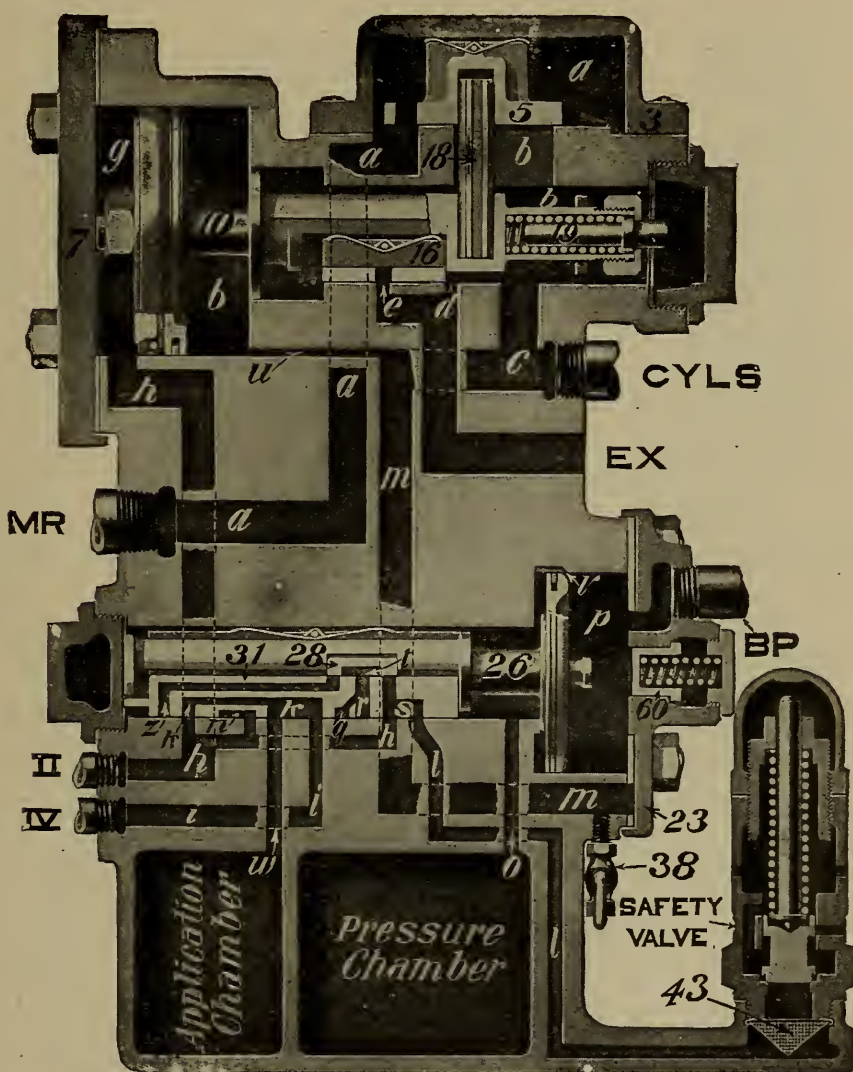


PLATE 76.

application cylinder and chamber. It has also closed port *s*, cutting off communication to the safety valve, so that any leak in the latter cannot reduce the application cylinder pressure, and thus similarly affect the pressure in the brake cylinders.

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The flow of air past application valve 5 to the brake cylinders continues until their pressures slightly exceed that in the application cylinder, when the higher pressure and application piston

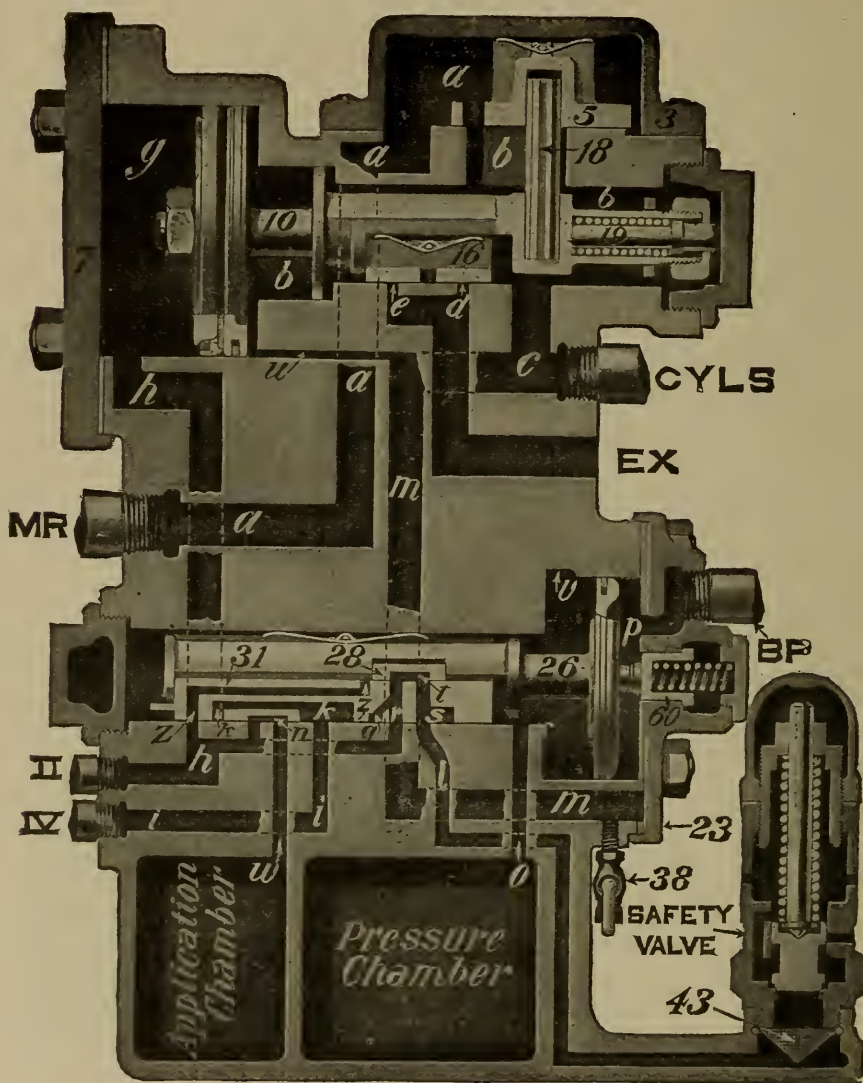


PLATE 77.

graduating spring, acting together, force piston 10 to the left, as shown on Plate 78, thereby closing port b. Further movement is prevented by the resistance of exhaust valve 16 and the appli-

cation piston graduating spring, which has expanded to its normal position. The brake cylinder pressure is then practically the same as that in the application cylinder and chamber.

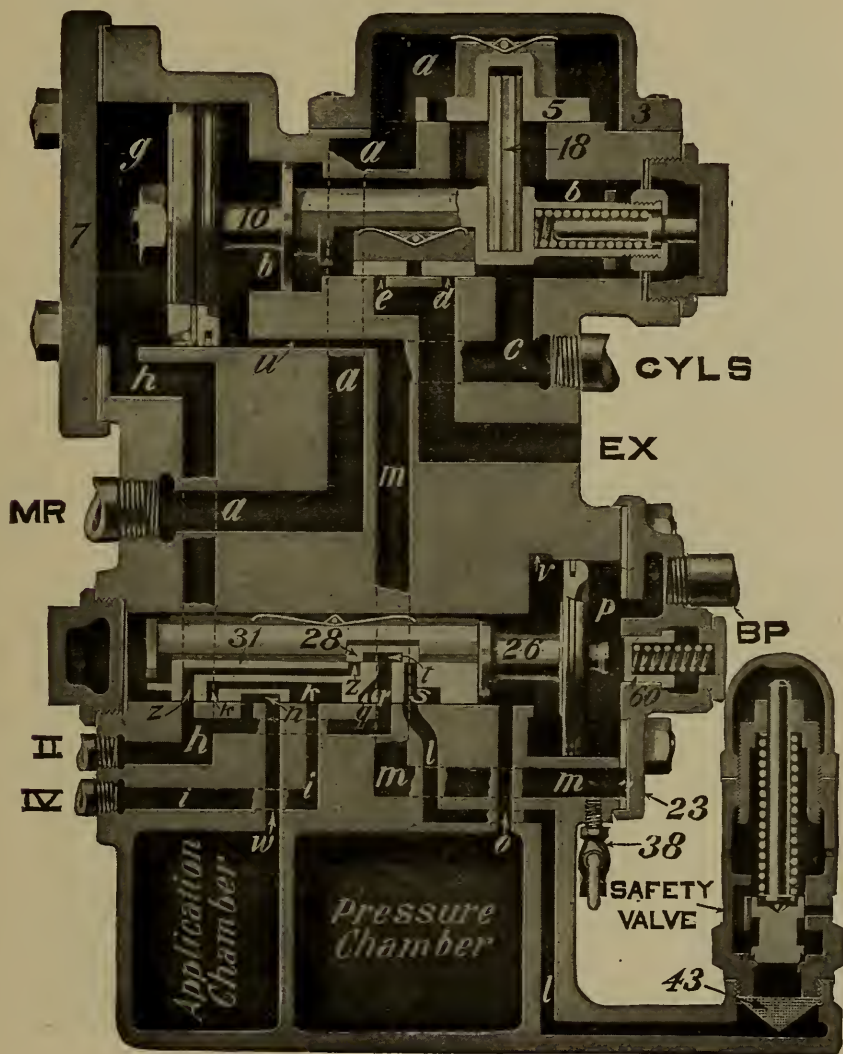


PLATE 78.

It will thus be seen that application piston 10 has application cylinder pressure on one side and brake cylinder pressure on the other. When either pressure varies, the piston will move to-

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ward the lower pressure. Consequently if the pressure in chamber *b* is reduced by brake cylinder leakage, the pressure maintained in the application cylinder will force piston 10 to the right,

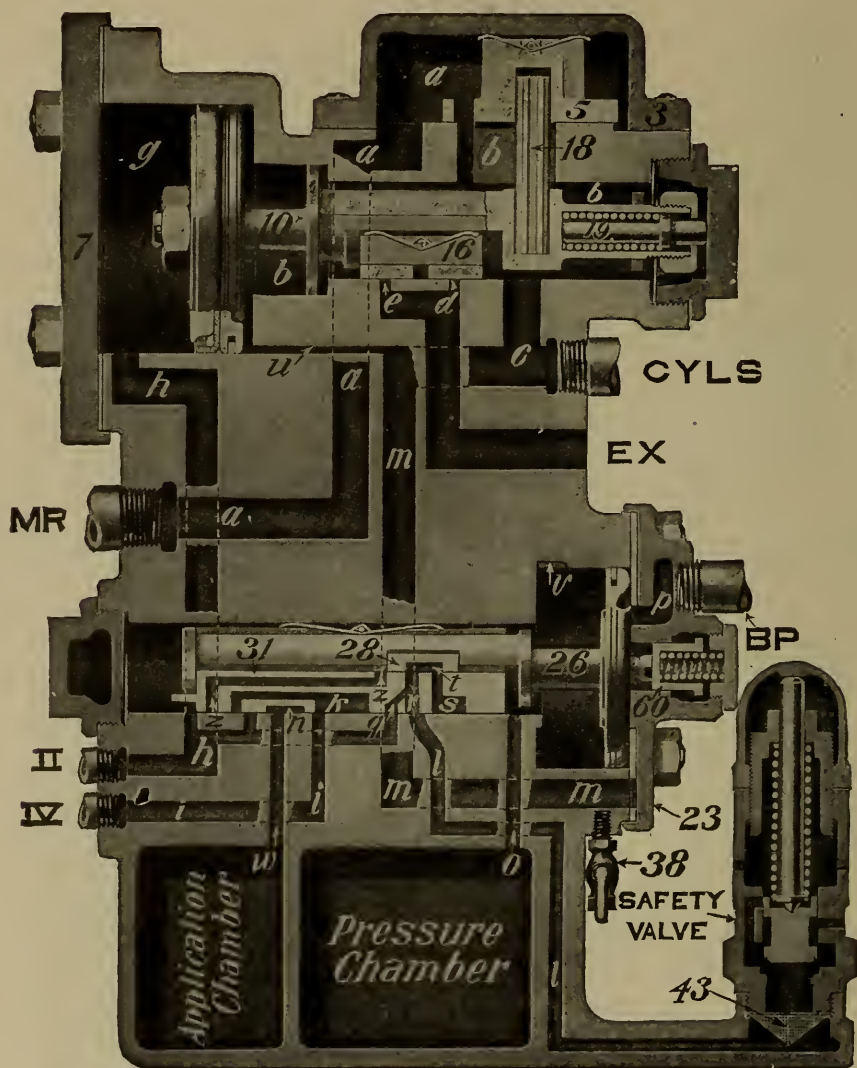


PLATE 79.

opening application valve 5 and again admitting air from the main reservoirs to the brake cylinders until the pressure in chamber *b* is again slightly above that in the application cylinder, when the piston again moves back to lap position. In this manner the

brake cylinder pressure is always maintained equal to that in the application cylinder. This is known as the pressure maintaining feature.

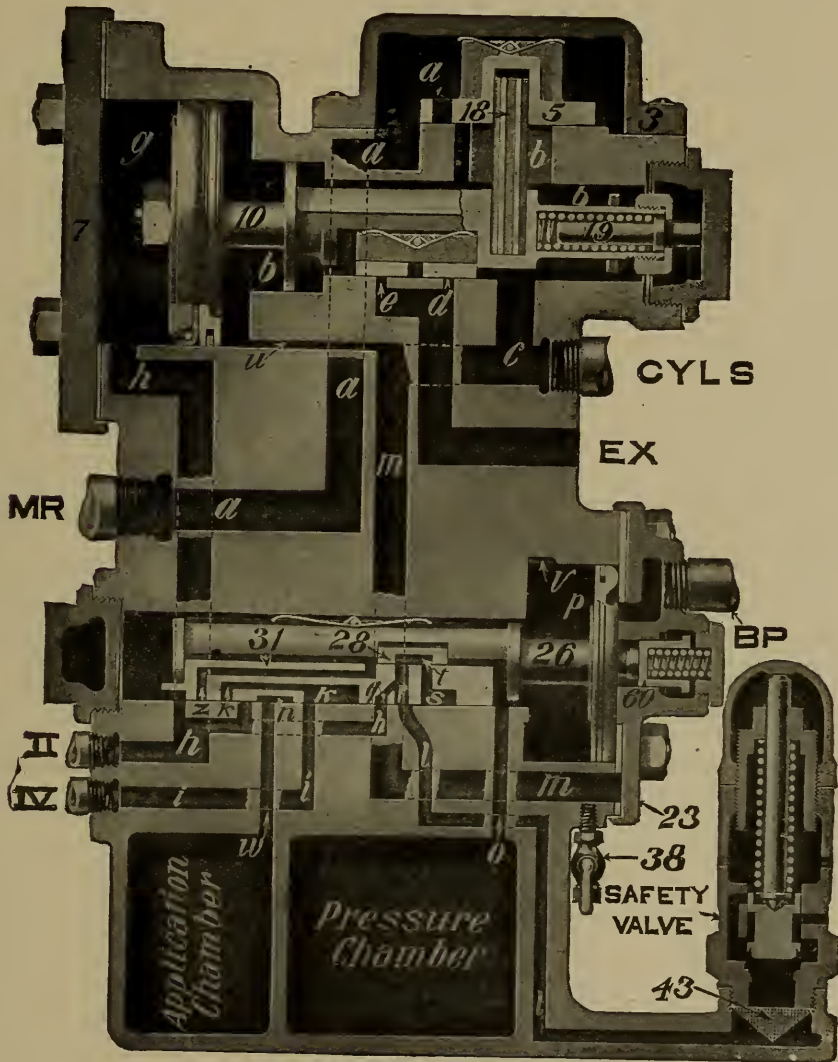


PLATE 80.

Automatic Release. When the automatic brake valve is placed in release position, and the brake pipe pressure in chamber *p* is thereby increased above that in the pressure chamber, equalizing piston 26 moves to the left, carrying with it equaliz-

ing valve 31 and graduating valve 28 to the position shown on Plate 76. Feed groove *v* now being open permits the pressure in the pressure chamber to increase until it is equal to that in the brake pipe, as before described.

This action does not release the locomotive brakes, as it does not discharge the application cylinder pressure. The release pipe is closed by the rotary valve of the automatic brake valve, and the application cylinder pipe is closed by the rotary valve of both brake valves. To release the locomotive brakes, the automatic brake valve must be moved to running position. The release pipe is then connected with the atmosphere by the rotary valve, and as exhaust cavity *k* in equalizing valve 31 connects ports *i*, *w* and *h* in the valve seat, application cylinder and chamber pressure will escape. As this pressure reduces, the brake cylinder pressure will force application piston 10 to the left, until exhaust valve 16 uncovers exhaust ports *d* and *e*, allowing the brake cylinder pressure to escape (Plate 76); or in case of a graduated release, reduces the brake cylinder pressure in like proportion to the reduction in the application cylinder pressure.

Emergency. When a sudden and heavy brake pipe reduction is made, as in an emergency application, the air in the pressure chamber forces equalizing piston 26 to the right with sufficient force to compress equalizing piston graduating spring 46, so that the piston moves until it strikes the leather gasket beneath cap 23, as shown on Plate 79. This movement causes equalizing valve 31 to uncover port *h* in the bushing, without opening port *w*, making a direct opening from the pressure chamber to the application cylinder only, so that the pressures quickly equalize. This cylinder volume being small and connected with that of the pressure chamber, a pressure of 70 pounds will equalize at about 65 pounds. Also in this position of the automatic brake valve, a small port in the rotary valve allows air from the main reservoirs to feed into the application cylinder pipe and thence to the application cylinder. The application cylinder is now connected to the safety valve through port *h* in

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the seat, cavity *q* and port *r* in the equalizing valve, and port *z* in the seat. Cavity *q* and port *r* in the equalizing valve are connected by a small port, the size being such that it permits the air

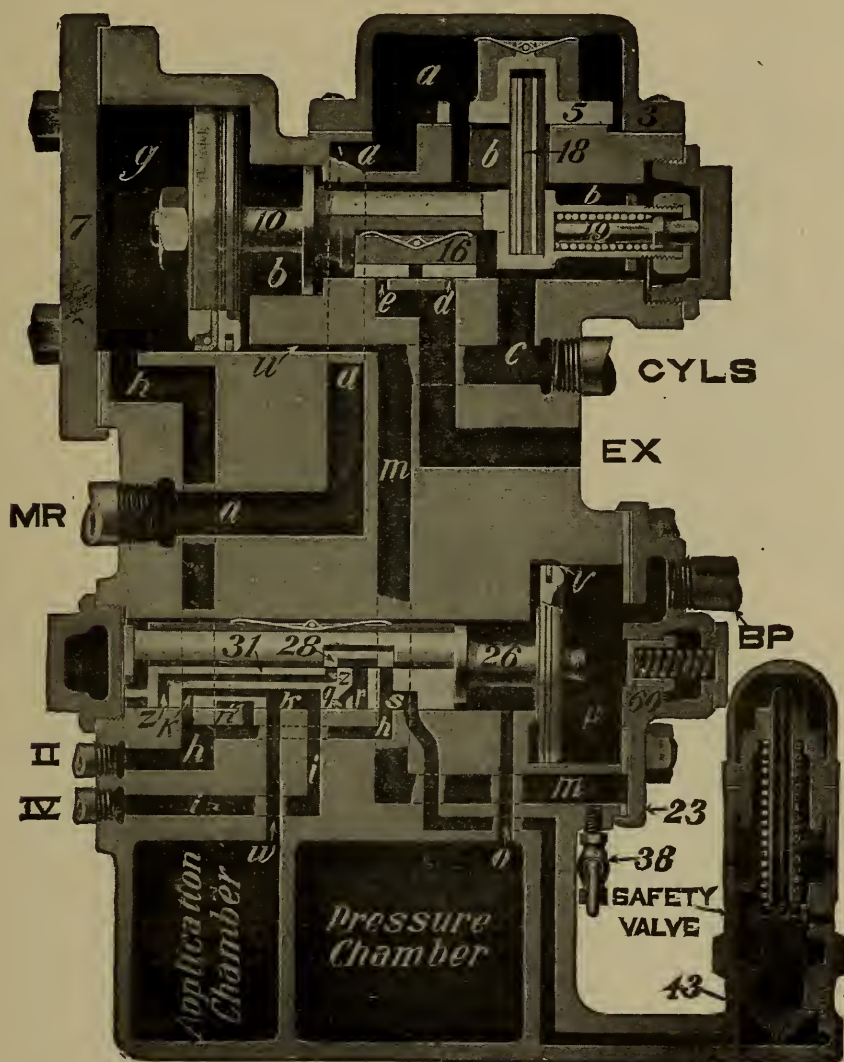


PLATE 81.

in the application cylinder to escape through the safety valve at the same rate as the air from the main reservoirs, feeding through the rotary valve of the automatic brake valve, can supply

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it, thus preventing the pressure from rising above the adjustment of the safety valve.

High Speed Service. In high speed brake service the feed valve is regulated for 110 pounds brake pipe pressure instead of

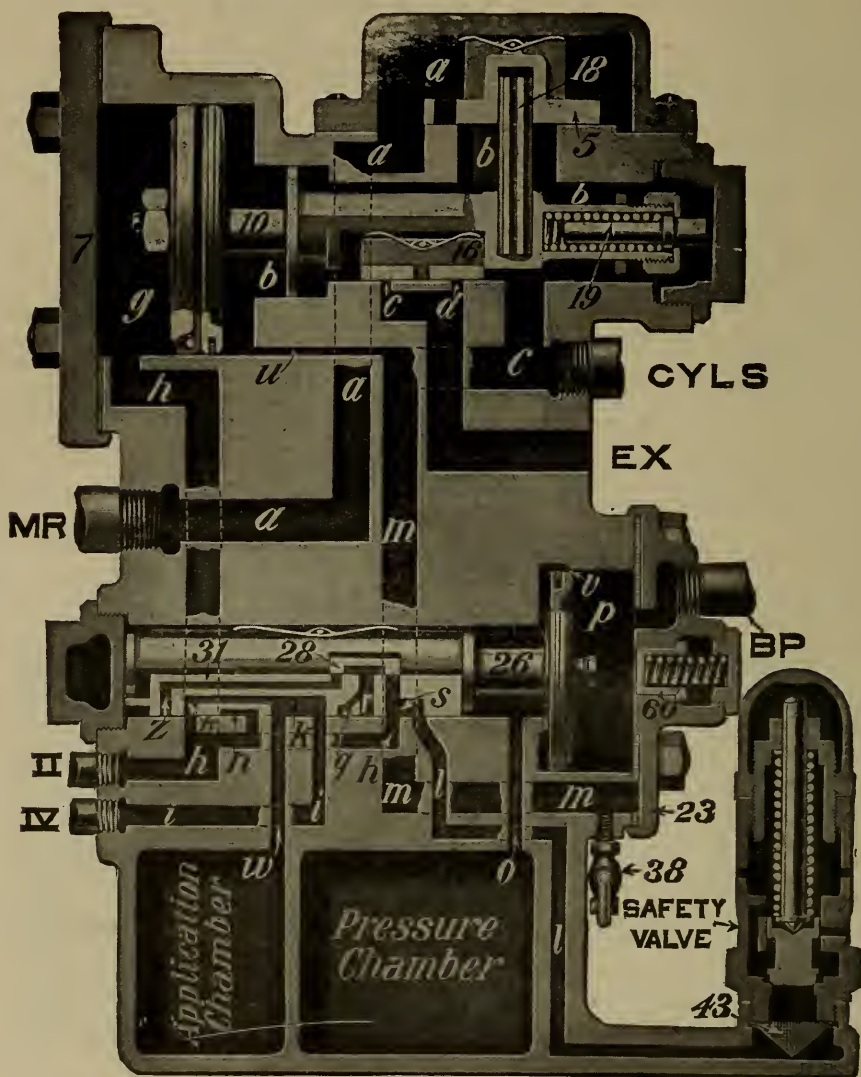


PLATE 82.

70, and the main reservoir pressure is from 130 to 140 pounds. Under these conditions an emergency application will raise the application cylinder pressure to about 93 pounds, but the passage

between cavity q and port r is so small that the flow of application cylinder pressure to the safety valve is just enough greater than the supply through the brake valve to decrease that pressure in practically the same time and manner as is done by the high speed reducing valve, until it is approximately 75 pounds. The reason why the pressure in the application cylinder, pressure chamber and brake cylinders does not fall to 68 pounds, to which pressure the safety valve is adjusted, is because the inflow of air through the brake valve with the high main reservoir pressure used in high speed service is equal, at 75 pounds, to the outflow through the small opening to the safety valve. This is done in order to permit of shorter stops in emergency applications. The application portion of the distributing valve operates similarly, but more quickly in emergency than in service application.

Emergency Lap. The movable parts of the valve remain in the position shown on Plate 79 until the brake cylinder pressure slightly exceeds that in the application cylinder, when the application piston and application valve move back to the position shown on Plate 80, which is known as emergency lap.

Releasing. The release, after an emergency application, is produced by the same manipulation of the automatic brake valve as that following a service application, but the effect on the distributing valve is somewhat different. When the equalizing piston, valve and graduating valve are forced to release position by the increased brake pipe pressure in chamber p , the application chamber, with no pressure in it, is connected to the application cylinder, with the emergency pressure in it, through port w , cavity k and port h . The pressure in the application cylinder at once expands into the application chamber until these pressures are equal, which results in the release of brake cylinder pressure until it is slightly less than that in the application cylinder and chamber. Consequently in releasing after an emergency application, the brake cylinder pressure will automatically reduce to about 15 pounds, and it will remain at this pressure until the automatic brake valve is moved to running position.

Application by Conductor's Valve, Train Parting, or Bursted Hose. If the brakes are applied by the use of a conductor's valve, a bursted hose, or the train parting, the movement of equalizing valve 31 breaks the connection between ports *h* and *i* through cavity *k*, so that the brakes will remain applied until the brake pipe pressure is restored. The handle of the automatic brake valve should be moved to lap position to prevent any loss of main reservoir pressure.

INDEPENDENT BRAKE OPERATION.

Independent Application. When the handle of the independent brake valve is moved to either application position, air from the main reservoir, limited to a maximum pressure of 45 pounds by the reducing valve, flows to the application cylinder, forcing application piston 10 to the right, as shown on Plate 81. This movement opens the port of application valve 5, allowing air from the main reservoirs to flow into chambers *b, b*, and through passage *c* to the brake cylinders, as in an automatic application, until the pressure slightly exceeds that in the application cylinder. The application piston graduating spring and the higher pressure then force application piston 10 to the left, until application valve 5 closes its port. Further movement is prevented by the resistance of exhaust valve 16 and the application piston graduating spring having expanded to its normal position. This position, shown on Plate 82, is known as independent lap.

It will be seen that whatever pressure exists in the application cylinder will be maintained in the brake cylinders by the pressure maintaining feature previously described.

Independent Release. When the handle of the independent brake valve is moved to release position a direct opening is made from the application cylinder to the atmosphere. As the application cylinder pressure escapes, the brake cylinder pressure in chambers *b* moves application piston 10 to the left, causing exhaust valve 16 to open exhaust ports *e* and *d*, as shown on Plate 76, thereby allowing brake cylinder pressure to escape to the atmosphere.

If the independent brake valve is returned to lap position before all of the application cylinder pressure has escaped, application piston 10 will return to independent lap position as soon as the brake cylinder pressure is reduced a little below that remain-

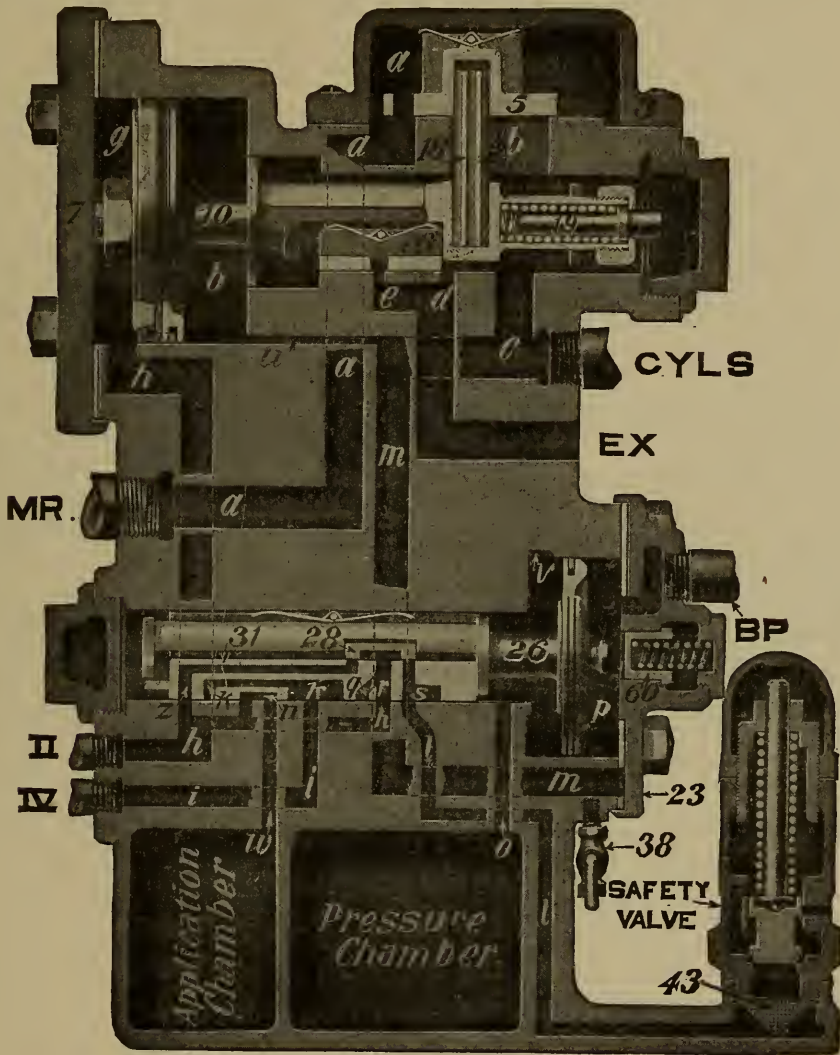


PLATE 83.

ing in the application cylinder, thus closing exhaust ports *e* and *d*, and holding the remaining pressure in the brake cylinders. In this way the independent brake release may be graduated as desired.

This equipment possesses all the flexibility and ease of manipulation embodied in the combined automatic and straight air equipment, with much less apparatus and complication, besides the additional important features of pressure maintaining, equal pressures in all brake cylinders, and the fact that it is always possible to release the locomotive brakes with the independent brake valve, even when automatically applied. In connection with this last-mentioned feature, Plate 83 shows the positions the distributing valve parts will assume if the locomotive brakes are released by the independent brake valve after an automatic application has been made. This results in the application portion moving to release position without changing the conditions in either the pressure chamber or the brake pipe; consequently the equalizing portion does not move until release is made by the automatic brake valve.

An independent release of locomotive brakes can also be made in the same manner after an emergency application by the automatic brake valve. However, owing to the fact that in this position the automatic brake valve will be supplying the application cylinder through the maintaining port in the rotary valve, the handle of the independent brake valve must be held in release position to prevent the locomotive brakes from reapplying, so long as the handle of the automatic brake valve remains in emergency position. The equalizing portion of the distributing valve will remain in the position shown on Plates 79 and 80, while the application portion will assume the position shown on Plate 83.

Two or More Engines in a Train. When there are two or more locomotives in a train the handles of both brake valves on each locomotive, except the ones from which the brakes are being operated, should be carried in running position. The release pipe is then open to the atmosphere at the automatic brake valve, and the operation of the distributing valve is the same as that in automatic brake applications. In double-heading, therefore, the application and release of the distributing valve on each helper locomotive is similar to that of the triple valves on the train. But

if it is necessary for the engineman or a helper to apply or release his brakes independently of those on the train he can do so by using the independent brake valve, without moving the handle of the automatic brake valve.

Condensation. Port U drains the application cylinder of any moisture caused by the condensation of air in chambers *b*, and this moisture passes to the lower part of the distributing valve through port *m*, from whence it may be drawn off by drain cock 38.

Removing the Parts. To remove piston 10 and slide valve 16, it is necessary first to remove cover 3, application valve 5, and valve pin 18.

QUICK ACTION CYLINDER CAP.

The equalizing portion of the distributing valve, as already described, corresponds to the plain triple valve of the old standard locomotive brake equipment. There are, however, conditions

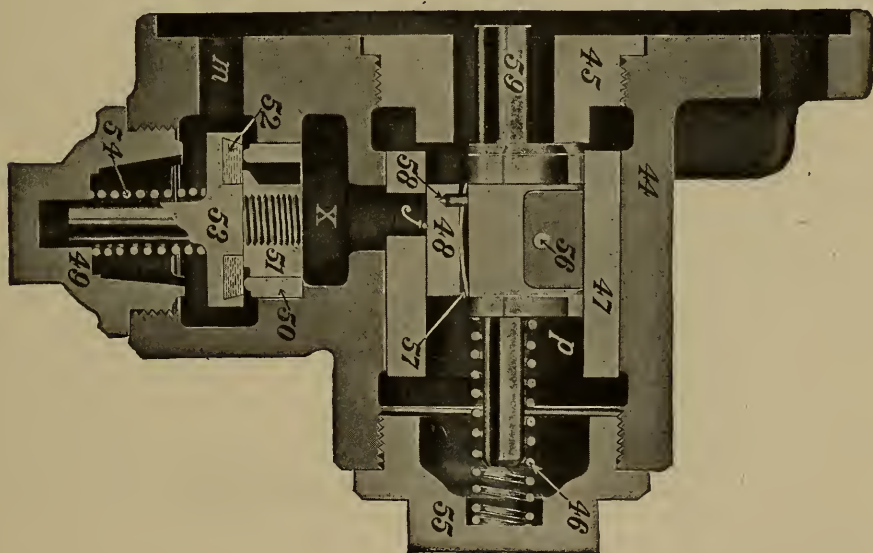


PLATE 84.

under which it is advisable to have it correspond to a quick action triple; that is, vent brake pipe air into the brake cylinders in an emergency application. To obtain this result, cylinder cap 23

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(Plate 74) is replaced by the quick action cylinder cap shown on Plate 84.

In an emergency application, as equalizing piston 26 moves to the right and seals against the gasket (Plate 85), the knob on the piston strikes graduating stem 59, which compresses

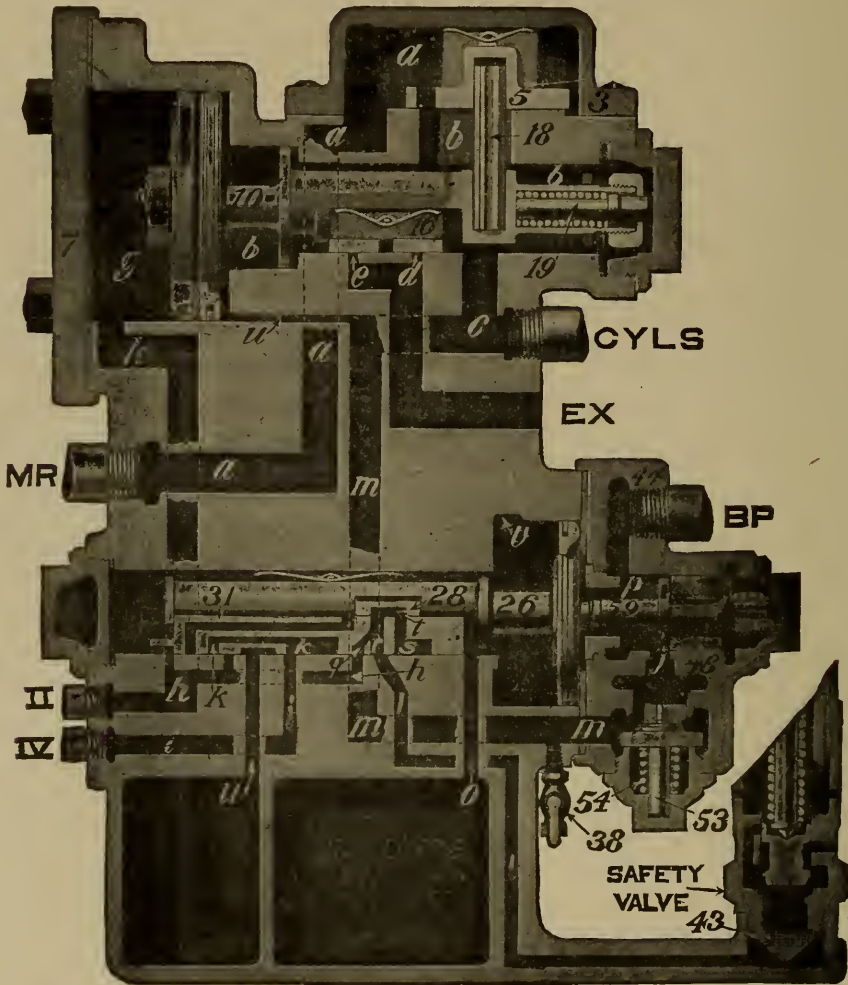


PLATE 85.

equalizing piston graduating spring 46 and moves slide valve 48 to the right, opening port *j*. The brake pipe pressure in chamber *p* flows to chamber X, forces check valve 53 downward, and passes to the brake cylinders through port *m* in

the cap and distributing valve body. When the pressures in the brake cylinders and the brake pipe equalize, check valve 53 is forced to its seat by spring 54, thus preventing the air in the brake cylinders from flowing back into the brake pipe. When a release of the brakes occurs, and piston 26 is moved back to its normal position (Plate 76), spring 46 forces graduating stem 59 and slide valve 48 back to the position shown on Plate 84.

In all other respects, the operation of a distributing valve provided with this cap is the same as previously described.

DEFECTS OF THE DISTRIBUTING VALVE.

Leaks. If application valve 5 leaks or becomes cut, allowing air to pass it while in lap position, it will increase the brake cylinder pressure above that in the application chamber and force application piston 10 and the application valve back far enough to allow the surplus air to escape at the brake cylinder exhaust port. This leak can be detected by the escape of brake cylinder air at the exhaust port during a brake application, or when the distributing valve is in release position.

If exhaust valve 16 leaks it will cause a constant blow from the exhaust port while the brakes are applied. It will not release the brake, as the leak will reduce the pressure slightly on the brake cylinder side of the piston, and the application pressure will move piston 10 and valve 5 so as to maintain a sufficient supply of air to overcome the effect of the leak, and the brake will not release as long as pressure remains in the application chamber. This leak can be detected by a blow from the brake cylinder exhaust port while the brakes are applied.

A leaky packing leather (13) and packing ring (15) in the application piston would, if there were any leaks in the brake cylinder and the brakes were applied, allow the air to leak from the application chamber by the packing leather and ring, and both pressures would be reduced, allowing the brake to leak off. If on the other hand there was no leak by piston 10, but there was

a leak in the brake cylinder, the air in the application chamber would hold valve 5 in such a position as to constantly supply the air lost through brake cylinder leakage.

If equalizing slide valve 31 leaks, when both brake valves are in running position, there will be a slight blow at the emergency exhaust port of the automatic brake valve. If the independent brake valve is placed in application position there will be an increase in application chamber pressure, which will cause the brakes to apply with greater force than intended. If the automatic brake valve handle is placed in partial service position, the application chamber pressure will increase and the brakes continue to set with greater force until the pressures are fully equalized. If the high speed pressure is used, it will increase the pressure in the application chamber until the safety valve opens and relieves the application chamber of excess pressure. If the engine on which this leak occurred was second in a double-header, and air was leaking from slide valve 31 so as to allow the air in the application chamber to leak to the pipe leading to the double cut-out cock underneath the brake valve, it would release the brake on this engine.

A leak in the pipe connection leading from the distributing valve to the independent brake valve would cause the brake to leak off with either an automatic or an independent application.

A leak in the pipe connection between the independent and automatic brake valves would affect an automatic application, but not an independent brake application.

A leak in the pipe connection between the distributing valve and underneath the brake valve would have no effect if an application was made with the automatic brake valve, but if a release of an automatic application of the train brakes was made it would gradually destroy the holding features of the automatic brake valve. If an independent brake application was made and the handle of the independent brake valve was placed in lap position, this leak would cause a gradual release of the engine brakes.

A leak in the pipe connection leading from the main reservoir

to the distributing valve will have no effect on the brake if the air pump maintains the main reservoir pressure.

Leaky Rotary. If the rotary valve of the independent brake valve leaks it will cause a slight blow at the emergency exhaust of the automatic brake valve, but if either the automatic or the independent brake valve is placed in partial service application position it will cause the pressure in the application chamber to increase to the maximum adjustment of the pressure reducing valve and cause the brake to apply with full independent pressure, while the handle of the automatic brake valve is in release or holding position. It will also cause a building up of pressure in the application chamber.

Leaky Graduating Valve. If graduating valve 28 leaks in release position it will not affect the brakes, but if a partial service application is made it will cause the brakes to release in a manner similar to that of a leaky slide valve.

Broken Graduating Spring. If graduating spring 20 should break, the application piston and valve would be less sensitive in graduating and would allow just enough more pressure in the brake cylinder to overcome the tension of graduating spring 20 and allow the pressure in the application chamber to move piston 10 and valve 5 far enough to cut off the supply of air from the brake cylinder.

THE E-6 SAFETY VALVE.

Plate 86 is a sectional view of the safety valve, which is an essential part of the distributing valve. It is unlike the ordinary safety valve, as its construction is such as to cause it to close quickly with a "pop" action, insuring its seating firmly. It is sensitive in operation and responds to slight variations of pressure.

List of Parts. The names of the parts composing this valve are as follows:

- | | |
|-------------|----------------------|
| 2. Body. | 5. Valve Stem. |
| 3. Cap Nut. | 6. Adjusting Spring. |
| 4. Valve. | 7. Adjusting Nut. |

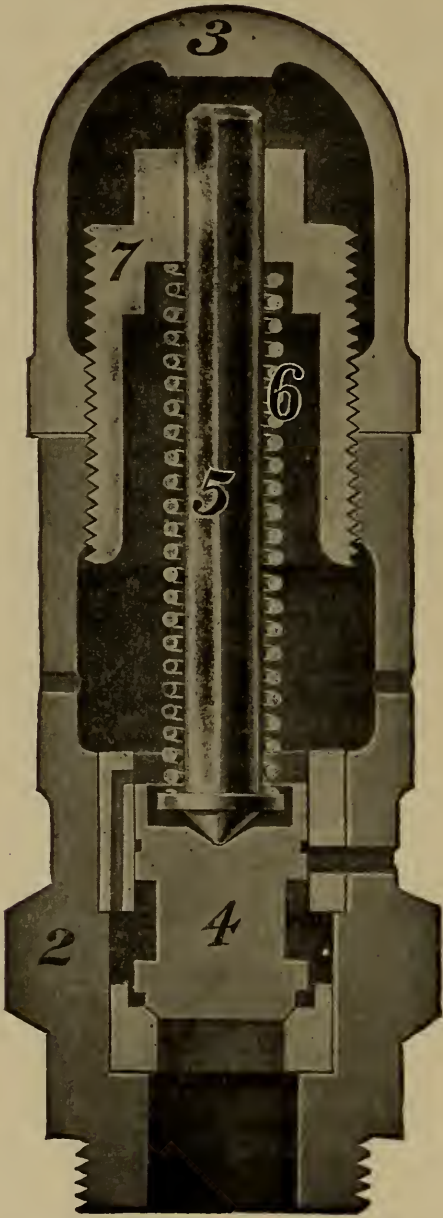


PLATE 86.

Operation. Valve 4 is held to its seat by the compression of spring 6 between the stem and adjusting nut 7. When the pressure below valve 4 is greater than the force exerted by the spring the valve rises, and as a larger area is then exposed its movement upward is very rapid, and is guided by the brass bushing in body 2. Two ports are drilled in this bushing upward to the spring chamber, and two outward through the body to the atmosphere, although only one of each of these ports is shown in the cut. As the valve moves upward, its lift is determined by stem 5 striking cap nut 3. In its movement it closes the two vertical ports in the bushing connecting the valve and spring chambers, and opens the two lower ports leading to the atmosphere. As the air pressure below valve 4 decreases, and the compression of the spring forces the stem and valve downward, the valve restricts the lower ports leading to the atmosphere and opens those between the valve and spring chambers, giving the discharge air pressure access to the spring chamber. This chamber is always connected with the atmosphere by two small holes through body 2, and the air from the valve chamber enters more rapidly than it can escape through these holes, causing pressure to accumulate above the valve and assist the spring in closing it with the "pop" action previously mentioned.

Adjustment. The safety valve is adjusted by removing cap nut 3 and screwing up or down on adjusting nut 7. After the proper adjustment has been made, cap nut 3 must be replaced and securely tightened and the valve operated a few times. Particular attention must be given to see that the holes in the valve body are always open and that they are not changed in size. This is of particular importance with reference to the two upper holes.

The safety valve should be adjusted at 68 pounds. This adjustment is more accurately and easily made on a shop testing rack than in any other way.

THE H-6 AUTOMATIC BRAKE VALVE.

This brake valve, while conforming to a considerable extent to the principles embodied in previous styles of brake valves, is necessarily different in detail, for it not only performs the functions of other types, but also performs those necessary to obtain all the desirable operative features of the No. 6 distributing valve.

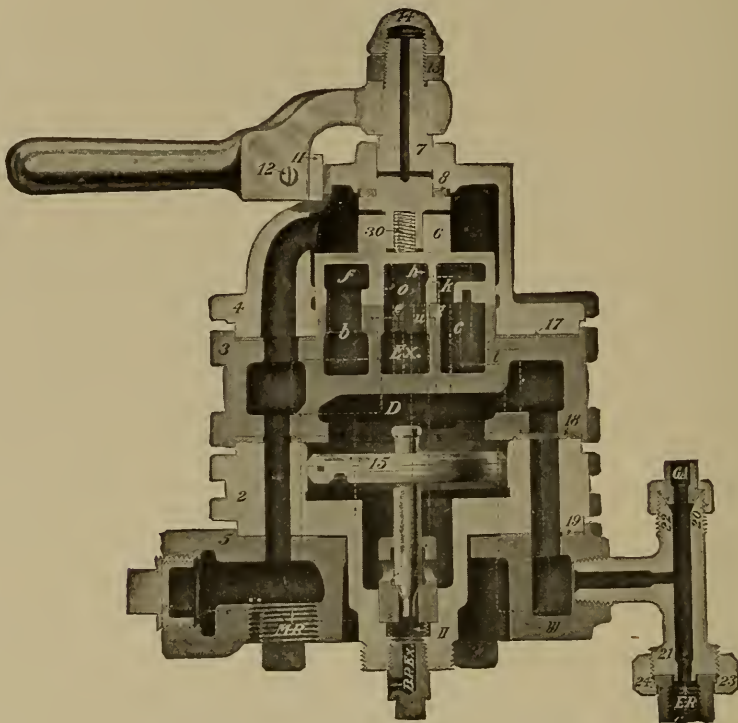


PLATE 87—FIGURE 1.

Views. Plate 87, Figs. 1 and 2, shows two views of this brake valve, Fig. 1, being a plain view, with a section through the rotary valve chamber, the rotary valve being removed, and, Fig. 2, a vertical section. The pipe connections are indicated in both views.

Plate 88 shows two views of this valve similar to those on Plate 87, with the addition of a plan or top view of the rotary valve. The six positions of the brake valve handle are, begin-

ning at the extreme left, release, running, holding, lap, service and emergency.

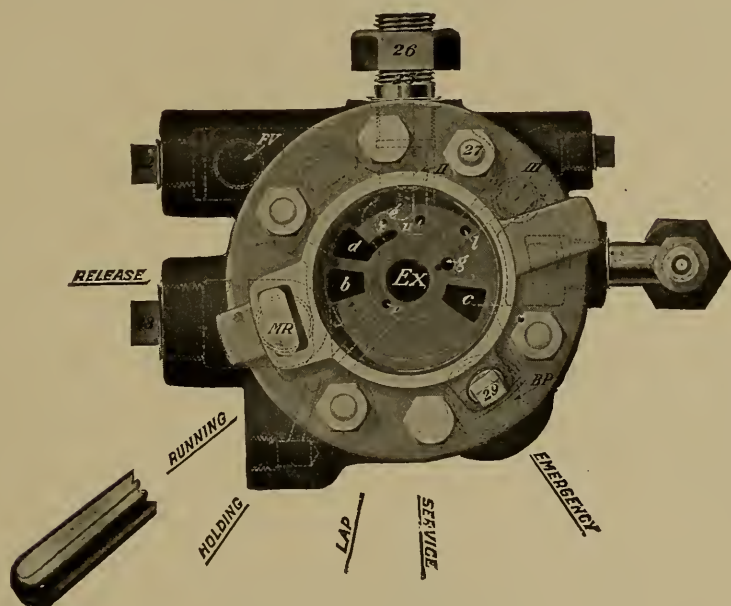


FIGURE 2—PLATE 87.

List of Parts. The names of the parts are as follows :

- | | |
|--|------------------------------|
| 2. Bottom Case. | 17. Valve Seat Upper Gasket. |
| 3. Rotary Valve Seat. | 18. Valve Seat Lower Gasket. |
| 4. Top Case. | 19. Pipe Bracket Gasket. |
| 5. Pipe Bracket. | 20. Small Union Nut. |
| 6. Rotary Valve. | 21. Brake Valve Tee. |
| 7. Rotary Valve Key. | 22. Small Union Swivel. |
| 8. Key Washer. | 23. Large Union Nut. |
| 9. Handle. | 24. Large Union Swivel |
| 10. Handle Latch Spring. | 25. Bracket Stud. |
| 11. Handle Latch. | 26. Bracket Stud Nut. |
| 12. Handle Latch Screw. | 27. Bolt and Nut. |
| 13. Handle Nut. | 28. Cap Screw. |
| 14. Handle Lock Nut. | 29. Oil Plug. |
| 15. Equalizing Piston. | 30. Rotary Valve Spring. |
| 16. Equalizing Piston Packing
Ring. | 31. Service Exhaust Fitting. |

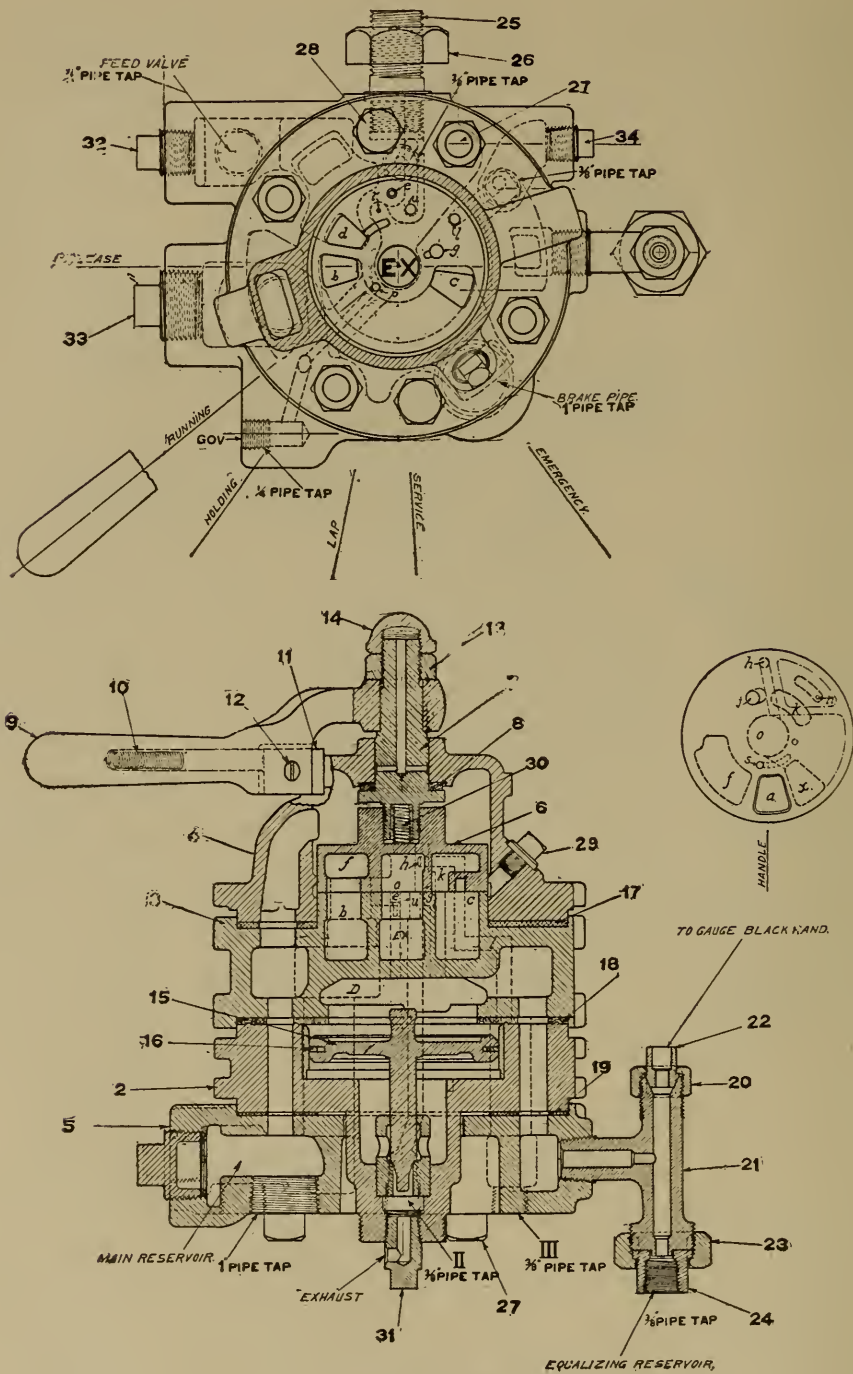


PLATE 88.

Ports. Referring to the rotary valve, *a*, *j* and *s* are ports extending directly through it, the latter connecting with a groove in the face; *f* and *k* are cavities in the valve face; *o* is the exhaust cavity; *x* is a port in the face of the valve, connected by a cored passage with *o*; *h* is a port extending from the face over cavity *k*, and connecting with exhaust cavity *o*; *n* is a groove in the face, having a small port which connects through a cavity in the valve with cavity *k*. Referring to the ports in the rotary valve seat, *d* leads to the feed valve pipe; *b* and *c* lead to the brake pipe; *g* leads to chamber D; EX is the exhaust opening leading out at the back of the valve; *e* is the preliminary exhaust port leading to chamber D; *r* is the **warning port** leading to the exhaust; *p* is the port leading to the pump governor; *l* leads to the distributing valve release pipe, and *u* leads to the application cylinder pipe.

In describing the operation of the brake valve it will be more readily understood if the positions are taken up in the order in which they are generally used, rather than in their regular order as given before.

Charging and Release Position. The purpose of this position is to provide a large and direct passage from the main reservoir to the brake pipe, permitting a rapid flow of pressure into the latter for the purpose of (1) charging the train brake system, and (2) quickly releasing and recharging the brakes, but not releasing the locomotive brakes, if they are applied.

Air at main reservoir pressure flows through port *a* in the rotary valve and port *b* in the valve seat to the brake pipe. At the same time port *j* in the rotary valve registers with equalizing port *g* in the valve seat, permitting the main reservoir pressure to enter chamber D above the equalizing piston.

If the handle were allowed to remain in this position, the brake system would become charged to main reservoir pressure. To avoid this, the handle of the brake valve must be moved to running or holding position. To prevent the engineman from forgetting this, a small port discharges feed valve pipe air to the

atmosphere in release position. Cavity *f* in the rotary valve connects port *d* with warning port *r* in the seat, and allows a small quantity of air to escape into exhaust cavity EX, which makes sufficient noise to attract the engineman's attention to the position of the brake valve handle.

The small groove in the face of the rotary valve which connects with port *s* extends to port *p* in the valve seat, allowing main reservoir pressure to flow to the excess pressure head of the pump governor.

Running Position. This is the proper position of handle (1) when the brake system is charged and ready for use; (2) when the brakes are not being operated, and (3) to release the locomotive brakes. In this position, cavity *f* in the rotary valve connects ports *b* and *d* in the valve seat, affording a large direct passage from the feed valve pipe to the brake pipe, so that the latter will become charged as rapidly as the feed valve can supply the air, but cannot attain a pressure above that for which the feed valve is adjusted. Cavity *k* in the rotary valve connects ports *c* and *g* in the valve seat, so that chamber D and the equalizing reservoir charge uniformly with the brake pipe, keeping the pressure on the two sides of the equalizing piston equal. Port *s* in the rotary valve registers with port *p* in the valve seat, permitting main reservoir pressure, which is present at all times above the rotary valve, to pass to the excess pressure head of the pump governor. Port *h* in the rotary valve registers with port *l* in the seat, connecting the distributing valve release pipe through exhaust cavity EX with the atmosphere.

If the brake valve is in running position when uncharged cars are cut in, or if, after a heavy brake application and release, the automatic brake valve is returned to running position too soon, the governor will stop the pump until the difference between the hands on gauge No. 1 is less than 20 pounds. The stoppage of the pump directs the engineman's attention to his improper operation of the brake valve, as running position results in delay in charging, and is liable to cause some brakes to stick. Release

position should be used until all brakes are released and the brake system is nearly charged.

Service Position. This position gives a gradual reduction of brake pipe pressure, causing a service application. Port *h* in the rotary valve registers with port *e* in the valve seat, allowing air from chamber D and the equalizing reservoir to escape to the atmosphere through cavities *o* in the rotary valve and EX in the valve seat. Port *e* is restricted so that the pressure in chamber D and the equalizing reservoir will be reduced gradually.

As all other ports are closed, the reduction of chamber D pressure allows the brake pipe pressure under the equalizing piston to raise it and unseat its valve, allowing brake pipe air to flow to the atmosphere gradually, through the opening marked BP Ex. When the pressure in chamber D is reduced to the desired amount, the brake valve handle is moved to lap position, thus stopping any further reduction in chamber D pressure. Air will then continue to flow from the brake pipe until its pressure has fallen to a trifle less than that retained in chamber D, permitting the pressure in this chamber to force the piston downward gradually and stop the discharge of brake pipe air. It will thus be seen that the amount of reduction in the equalizing reservoir determines the reduction in brake pipe pressure, regardless of the length of the train.

The gradual reduction in brake pipe pressure is to prevent quick action of the brakes, and the gradual stoppage of the brake pipe discharge is to prevent the premature release of the head brakes.

Lap Position. This position is used while holding the brakes applied after a service application until it is desired either to make a further brake pipe reduction or to release the brakes, and to prevent loss of main reservoir pressure in the event of a bursted hose, a break-in-two, or the opening of the conductor's valve. In this position, all ports are closed.

Release Position. This position, which is used for releasing the train brakes after an application, without releasing the loco-

motive brakes, has already been described under Charging and Release. The air flowing from the main reservoir pipe connection through port *a* in the rotary valve and port *b* in the valve seat to the brake pipe, raises the pressure in the latter, thereby causing the triple valves and the equalizing portion of the distributing valve to go to release position, which releases the train brakes, and recharges the auxiliary reservoirs and the pressure chamber in the distributing valve. When the brake pipe pressure has been increased sufficiently to cause this, the handle of the brake valve should be moved either to running or holding position; the former when it is desired to release the locomotive brakes and the latter when they are still to be held applied.

Holding Position. This position is so named because the locomotive brakes are held applied while the train brakes recharge to feed valve pressure. All ports register as in running position except port *l*, which is closed.

Therefore the only difference between running and holding positions is that in the former the locomotive brakes are released, while in the latter they are held applied.

Emergency Position. This position is used when the most prompt and heavy application of the brakes is required. Port *x* in the rotary valve registers with port *c* in the valve seat, making a large and direct communication between the brake pipe and atmosphere through cavity *o* in the rotary valve and EX in the valve seat. This direct passage makes a sudden and heavy discharge of brake pipe pressure, causing the triple valves and distributing valve to go to emergency position and give the maximum braking power in the shortest possible time.

In this position, main reservoir air flows to the application cylinder through port *j*, which registers with a groove in the seat connecting with cavity *k*; thence through ports *n* in the valve and *u* in the seat to the application cylinder pipe, thereby maintaining application cylinder pressure.

Lubrication. Oil plug 29 is placed in top case 4, at a point to fix the level of an oil bath in which the rotary valve operates.

The position of this oil hole is such that it is impossible to pour oil into the valves in excess of the amount required. This arrangement furnishes thorough lubrication. Valve oil should be used.

Preventing Leakage. Leather washer 8 prevents air in the rotary valve chamber from leaking past the rotary valve key to the atmosphere. Spring 30 keeps the rotary valve key firmly pressed against washer 8 when no main reservoir pressure is present. Handle 9 contains latch 11, which fits into notches in the quadrant of the top case, so located as to indicate the different positions of the brake valve handle. Handle latch spring 10 forces the latch against the quadrant with sufficient pressure to indicate each position.

Removing the Parts. To remove the brake valves, the cocks should be closed and nuts 27 taken off. To take the valve proper apart, cap screws 28 should be removed.

The brake valve should be located so that the engineer can operate it conveniently from his usual position, while looking forward or back out of the side cab window.

THE S-6 INDEPENDENT BRAKE VALVE.

Plate 89 shows a vertical section through the center of the valve and a horizontal section through the valve body, with the

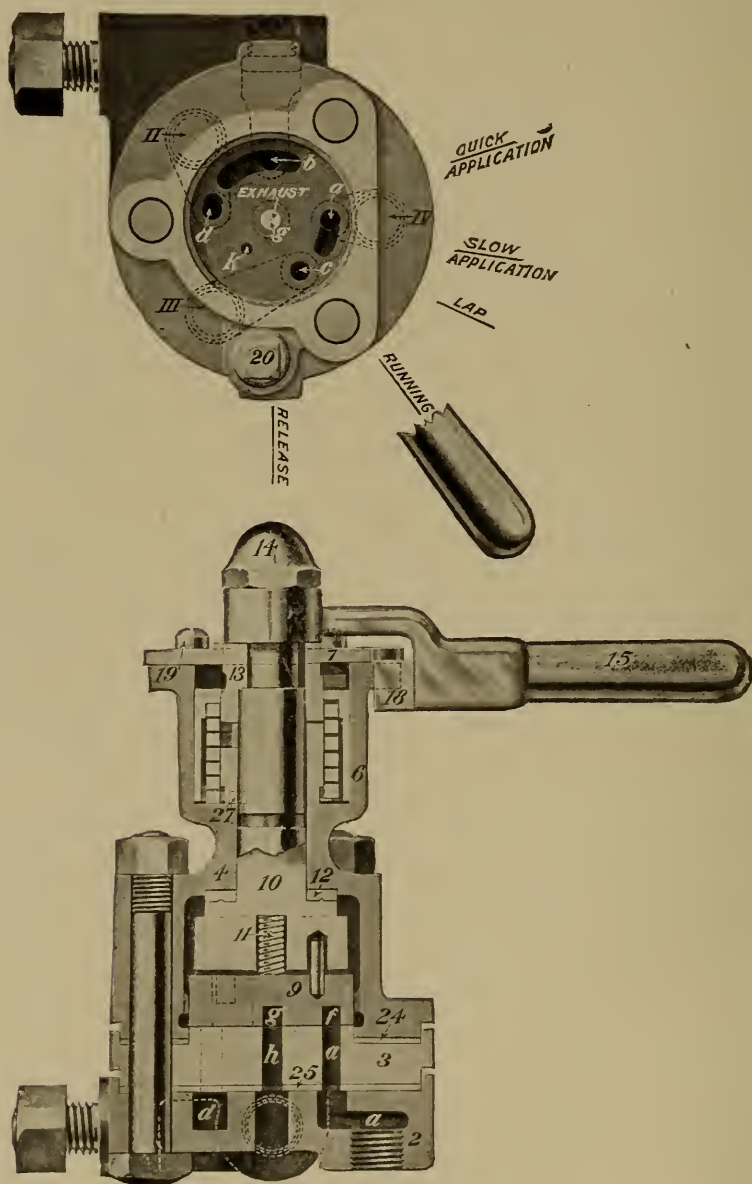


PLATE 89.

rotary valve removed, showing the rotary valve seat. Plate 90 shows this valve similarly to Plate 89, with the addition of a top

view of the rotary valve. In these views the pipe connections and positions of the handle are indicated.

List of Parts. Referring to Plate 90, the names of the parts are as follows:

- | | |
|--------------------------|-------------------------|
| 2. Pipe Bracket. | 16. Latch Spring. |
| 3. Rotary Valve Seat. | 17. Latch Screw. |
| 4. Valve Body. | 18. Latch. |
| 5. Return Spring Casing. | 19. Cover Screw. |
| 6. Return Spring. | 20. Oil Plug. |
| 7. Cover. | 21. Bolt and Nut. |
| 8. Casing Screw. | 22. Bracket Stud. |
| 9. Rotary Valve. | 23. Bracket Stud Nut. |
| 10. Rotary Valve Key. | 24. Upper Gasket. |
| 11. Rotary Valve Spring. | 25. Lower Gasket. |
| 12. Key Washer. | 26. Lower Clutch. |
| 13. Upper Clutch. | 27. Return Spring Stop. |
| 14. Handle Nut. | 28. Cap Screw. |
| 15. Handle. | |

Ports and Grooves. Port *b* in the seat leads to the reducing valve pipe. Port *a* leads to that portion of the distributing valve release pipe which connects to the distributing valve at IV (Plate 76). Port *c* leads to the other portion of the release pipe which connects to the automatic brake valve at III (Plate 87). Port *d* leads to the application cylinder pipe which connects to the distributing valve at II (Plate 76). Port *h* in the center is the exhaust port leading directly down to the atmosphere. Port *k* is the warning port, connecting with the atmosphere. Exhaust cavity *g* in the rotary valve is always in communication at one end with the exhaust port *h*. Groove *e* in the face of the valve communicates at one end with a port through the valve. This groove is always in communication with a groove in the seat connecting with supply port *b*, and through the opening just mentioned air is admitted to the chamber above the rotary valve, thus keeping it to its seat. Port *m* connects by a small hole with groove

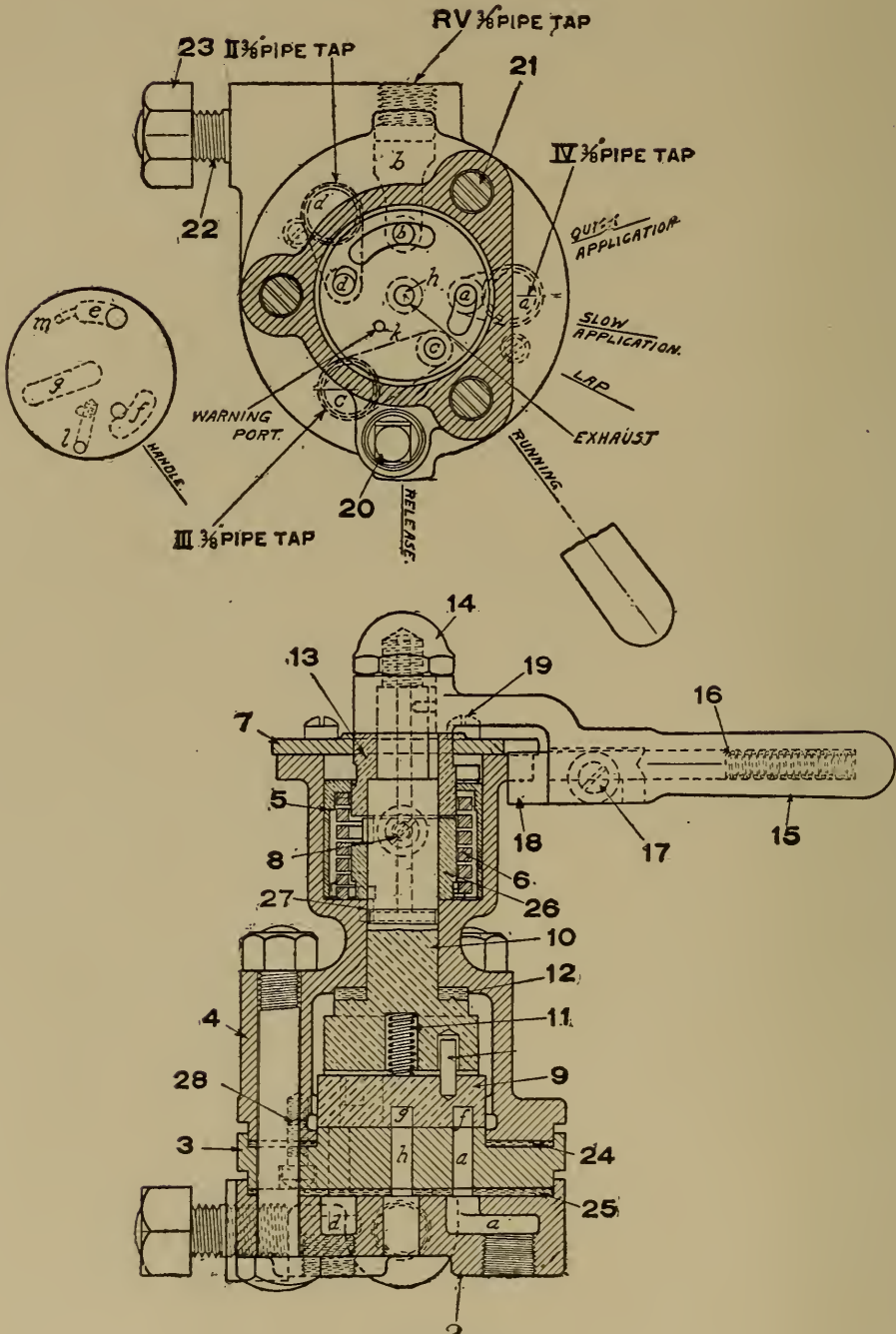


PLATE 90.

e; *f* is a groove in the face of the rotary valve; *l* consists of ports in top and face of valve connected by a passage.

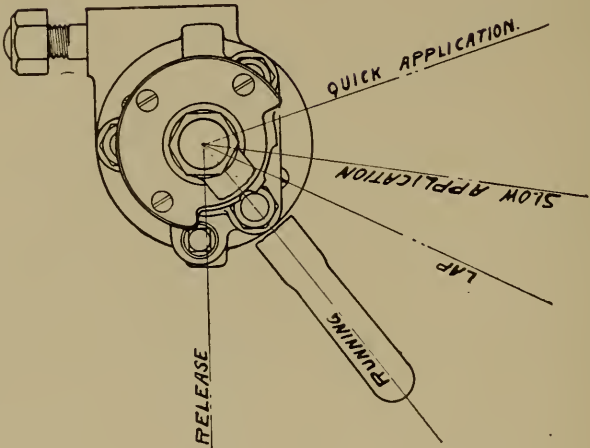
Running Position. This is a position in which the independent brake valve should be carried at all times when the independent brake is not in use. Groove *f* in the rotary valve connects ports *a* and *c* in the valve seat, thus establishing communication between the application cylinder of the distributing valve and port *l* of the automatic brake valve (Plate 87), so that the distributing valve can be released by the latter. It will also be noted that if the automatic brake valve is in running position, and the independent brakes are being operated, they can be released by simply returning the independent valve to running position, as the application cylinder pressure can then escape through the release pipe and automatic brake valve.

Slow Application Position. To apply the independent brakes lightly or gradually, the brake valve handle should be moved to slow application position. Port *m* then registers with port *d*, allowing air to flow from the reducing valve pipe through port and groove *b* in the seat, groove *e* in the rotary valve, and the comparatively small port *m* to port *d*; thence through the application cylinder pipe to the application cylinder of the distributing valve.

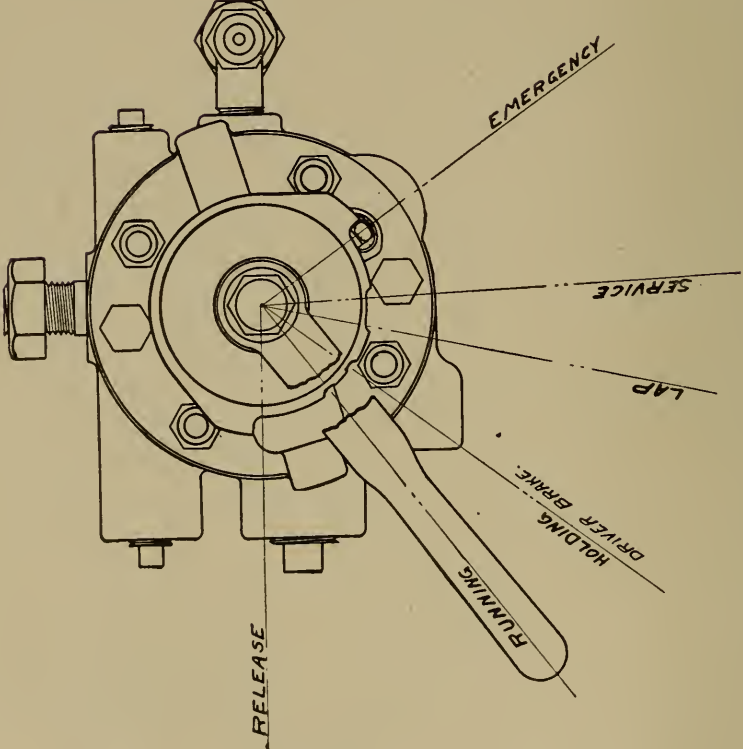
Quick Application Position. To obtain a quick application of the independent brake, the brake valve should be moved to quick application position. Groove *e* then connects ports *b* and *d* directly, making a larger opening between them than in the slow application position, and allowing supply air to flow rapidly from the reducing valve pipe to the application cylinder of the distributing valve. Since the supply pressure to this valve is determined by the adjustment of the reducing valve at 45 pounds, this is the maximum cylinder pressure that can be obtained.

Lap Position. This position is used to hold the independent brake applied after the desired cylinder pressure is obtained, at which time all communication between the operative ports is closed.

INDEPENDENT BRAKE VALVE
"S-G"



AUTOMATIC BRAKE VALVE
"H-G"



Release Position. This position is used to release the pressure from the application cylinder when the automatic brake valve is not in running position. At such time, the offset in cavity *g* registers with port *d*, allowing pressure in the application cylinder to flow through the application cylinder pipe, ports *d*, *g* and *h* to the atmosphere.

Purpose of Return Spring 6. The purpose of return spring 6 is to move handle 15 automatically from release to running position, or from quick application to slow application position, as soon as the engineman lets go of it. The automatic return from release to running position is to prevent the engineman from leaving the handle in the former position, and thereby make it impossible to operate the locomotive brake with the automatic brake valve. The action of the spring between quick application and slow application positions serves to accentuate the latter, so that in rapid operation of the valve the engineman is less likely unintentionally to pass over it to quick application position, thereby obtaining a heavy application of the locomotive brake when only a light one was desired. As a warning to the engineman in case of a broken return spring, port *l* in the face of the rotary registers in release position with port *k* in the seat, allowing air to escape to the atmosphere.

Oil Plug. The purpose of oil plug 20 is the same as that previously described in the automatic brake valve section.

Plate 91 gives a top view of both brake valves, showing the position of their handles.

THE B-6 FEED VALVE.

The B-6 feed valve, furnished with the No. 6 equipment, is an improved form of the slide valve type. It differs from previous types in charging to the regulated pressure somewhat quicker, and in maintaining the pressure more accurately under the variable conditions of short and long trains, and of good and poor maintenance. It also gives high and low brake pipe pressure control. It is supplied with air directly from the main reservoir. It regulates the pressure in the feed valve pipe, and also

the brake pipe in running and holding positions of the automatic brake valve, as the latter then connects the two pipes. It is connected to a pipe bracket located in the piping between the main reservoir and the automatic brake valve, and is interchangeable with previous types.

Plates 92 and 93 are diagrammatic views of the valve and pipe bracket, showing the ports and operative parts on one plane to facilitate description.

List of Parts. The names of the parts are as follows:

- | | |
|---------------------------|------------------------------|
| 2. Valve Body. | 13. Regulating Valve Spring. |
| 3. Pipe Bracket. | 14. Diaphragm. |
| 5. Cap Nut. | 15. Diaphragm Ring. |
| 6. Piston Spring. | 16. Diaphragm Spindle. |
| 7. Piston Spring Tip. | 17. Regulating Spring. |
| 8. Supply Valve Piston. | 18. Spring Box. |
| 9. Supply Valve. | 19. Upper Stop. |
| 10. Supply Valve Spring. | 20. Lower Stop. |
| 11. Regulating Valve Cap. | 21. Stop Screw. |
| 12. Regulating Valve. | 22. Adjusting Handle. |

This feed valve consists of two sets of parts, the supply and regulating. The supply parts, which control the flow of air through the valve, consist of supply valve 9 and its spring 10; supply valve piston 8 and its spring 6.

Regulating Parts. The regulating parts consist of the Regulating Valve 12, Regulating Valve Spring 13, Diaphragm 14, Diaphragm Spindle 16, Regulating Spring 17, and Adjusting Handle 22.

Main Reservoir Pressure. Main reservoir air enters through port *a*, *a*, to the supply valve chamber B, forces supply valve piston 8 to the left, compresses piston spring 6, and causes the port in supply valve 9 to register with port *c* (Plate 93). This permits air to pass through ports *c* and *d* to the feed valve pipe at FVP, and through port *e* to diaphragm chamber L.

Regulating valve 12 is then open and connects chamber G, on the left of piston 8, to the feed valve pipe through passage *h*,

port k , chamber L, and passage e, d, d . Air feeding by the piston cannot accumulate above feed valve pipe pressure. When regu-

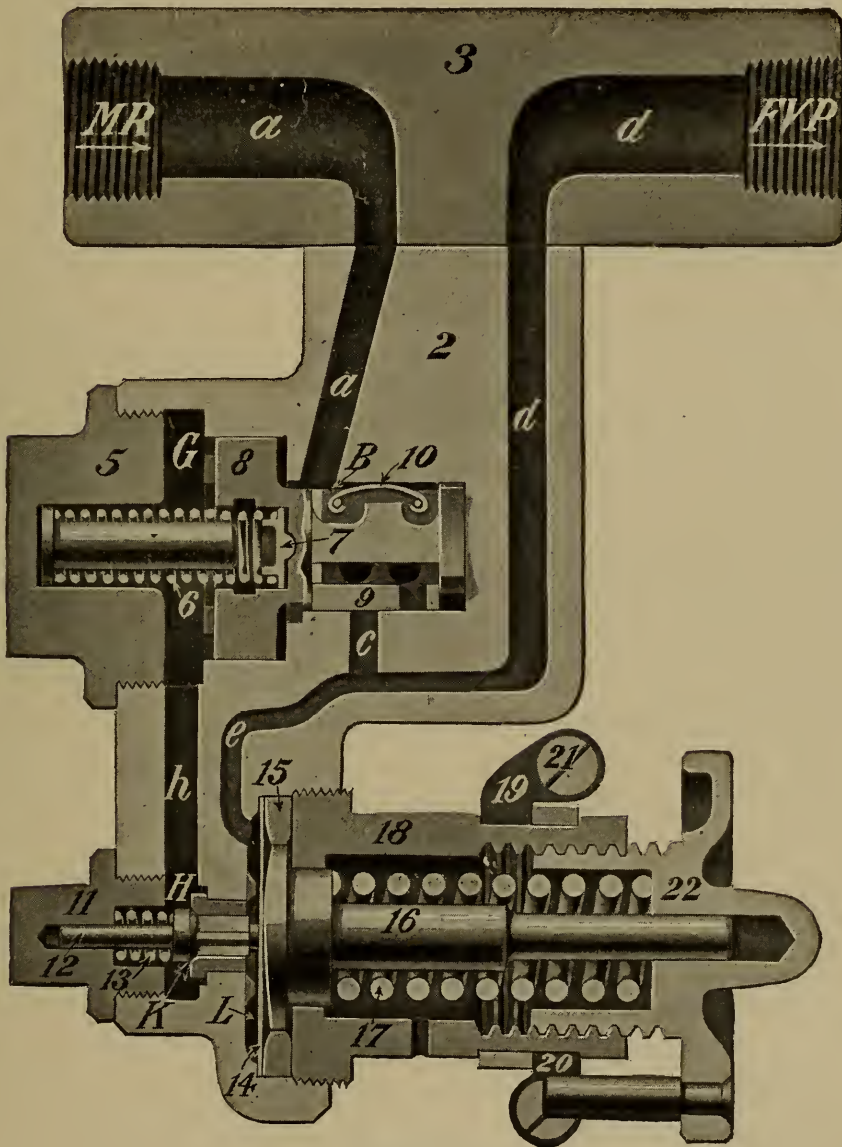


PLATE 92.

lating valve 12 is closed the pressure on the left of piston 8 quickly rises to the main reservoir pressure on the right, and piston spring 6 forces piston 8 and supply valve 9 to the right,

closing port *c* and stopping the flow of air to the feed valve pipe.

Regulating Valve. The regulating valve is operated by diaphragm 14. When the pressure of regulating spring 17 on its right is greater than the feed valve pipe pressure in chamber L on its left, it opens regulating valve 12. This causes the supply valve to admit air to the feed valve pipe. When the feed valve pipe pressure in chamber L becomes greater than the tension of regulating spring 17, the diaphragm allows regulating valve 12 to close. This causes the supply valve to stop admitting air to the feed valve pipe.

As previously explained, in release position of the H-6 automatic brake valve, the warning port is supplied from the feed valve pipe. This insures that the excess pressure governor head will regulate the brake pipe pressure in release position even though the feed valve is leaking slightly, but not enough to be otherwise detrimental.

Distinguishing Feature. The distinguishing feature of this type of feed valve is the duplex adjusting arrangement by which it eliminates the necessity of the two feed valves in high and low pressure service. The spring box 18 has two rings encircling it, which are split through the lugs marked 19 and 20 in the diagram, and which may be secured in any position by screw 21. The pin forming part of adjusting handle 22 limits the movement of the handle to the distance between stops 19 and 20. When testing the valve, stop 19 is located so that the compression of spring 17 will give the desired high brake pipe pressure, and stop 20 is located so that the spring compression is enough less to give the low brake pipe pressure. Thereafter, by simply turning handle 22 until its spring strikes either one of these stops, the regulation of the feed valve is changed from one brake pipe pressure to the other.

Adjustment. To adjust this valve, screws 21 should be slackened, which allows stops 19 and 20 to turn around spring box 18. Adjusting handle 22 should be turned until the valve closes at the lower brake pipe pressure desired, when stop 20 should be

NO. 6 ET LOCOMOTIVE BRAKE EQUIPMENT. 211

brought in contact with the handle pin, at which point it should be securely fastened by tightening screw 21. Adjusting handle

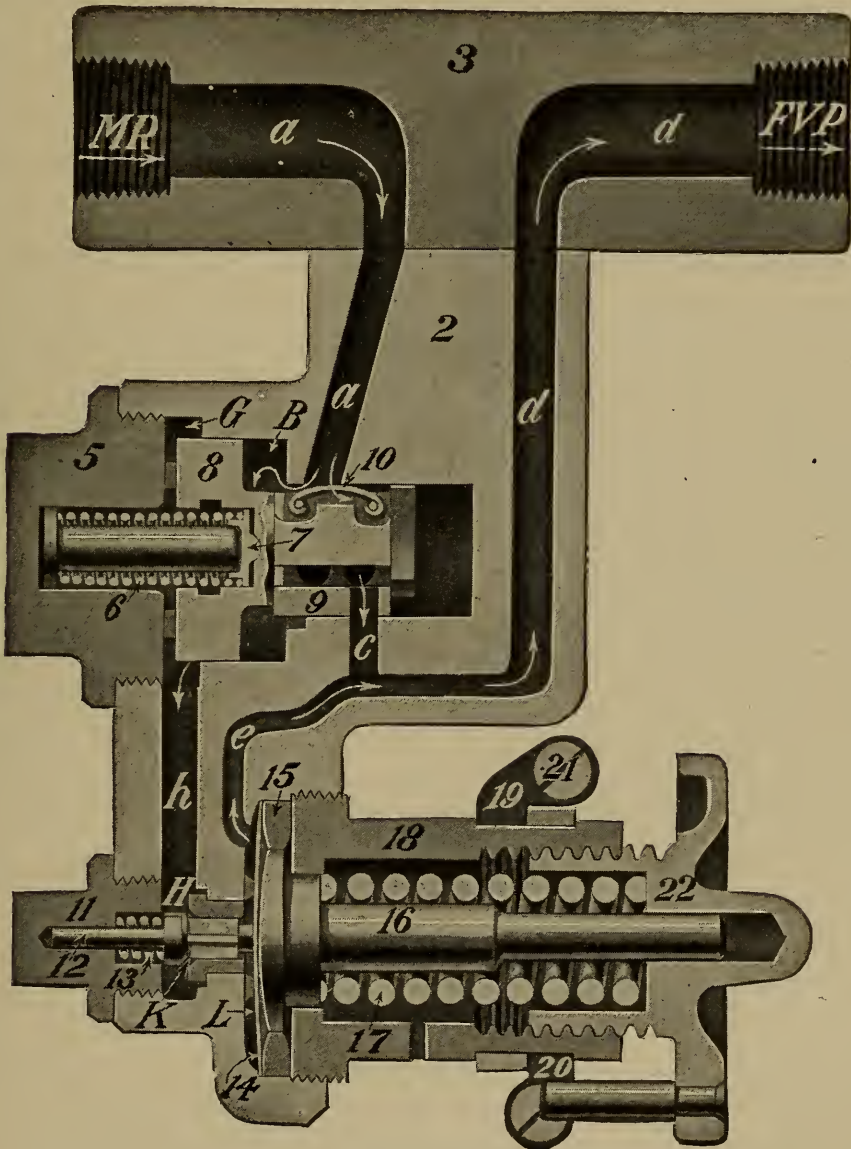


PLATE 93.

22 should then be turned until the higher adjustment is obtained, when stop 19 is brought in contact with the handle pin and se-

curely fastened. The stops should be placed to give 110 pounds high and 70 pounds low brake pipe pressure.

When replacing this feed valve on its pipe bracket after removal, the gasket must always be in place between the valve and bracket to insure a tight joint.

THE C-6 REDUCING VALVE.

This valve is the well-known feed valve that has been used for many years in connection with the G-6 brake valve, but in this equipment it is attached to a pipe bracket. The only difference between it and the B-6 feed valve just described is in the adjustment, it being designed to reduce main reservoir pressure to a single fixed pressure, which in this equipment is, as already stated, 45 pounds. To adjust this valve, the cap nut on the end of the spring box should be removed; this will expose the adjusting nut, by which the adjustment is made. It is called a reducing valve when used with the independent brake and air signal systems, simply to distinguish it from the feed valve supplying the automatic brake valve.

THE SF TYPE PUMP GOVERNOR.

The duty of the SF pump governor is to restrict the speed of the pump sufficiently when the desired main reservoir pressure is obtained, preventing this pressure from rising any higher. During most of the time when on the road the automatic brake valve is in running position, keeping the brakes charged. But little excess pressure is then needed and the governor regulates the main reservoir pressure to only about 20 pounds above the brake pipe pressure, thus making the work of the pump easier. On the other hand, when the brakes are applied, a high main reservoir pressure is needed to insure their prompt release and recharge. Therefore, as soon as the use of lap, service, or emergency position is commenced, the governor allows the pump to work freely until the maximum main reservoir pressure is obtained. Again, when the brake pipe pressure is changed from one amount to another by the feed valve, as where a locomotive is used alternately in high speed brake and ordinary service, the governor automatically changes the main reservoir pressure to the maximum, and at the same time maintains the other features just described.

Another important feature is that, before commencing and during the descent of steep grades, this governor enables the engineman to raise and maintain the brake pipe pressure about 20 pounds above the feed valve regulation merely by the use of release position of the automatic brake valve, the position which should be used during such braking.

Construction and Operation. Plate 94 shows a sectional view of this governor with steam valve 5 open. Connection B leads to the boiler; P to the air pump; MR to the main reservoir; ABV to the automatic brake valve; FVP to the feed valve pipe, and W is the waste pipe connection. Steam enters at B and passes by steam valve 5 to connection P, and thence to the pump. The governor regulating head on the left is called the excess pressure head and the one on the right the maximum pressure head. Air from the main reservoirs flows through the automatic brake valve (when the latter is in release, running or holding posi-

tion) to the connection marked ABV into chamber *d* below diaphragm 28. Air from the feed valve pipe enters at the connection FVP to chamber *f* above diaphragm 28, adding to the pres-

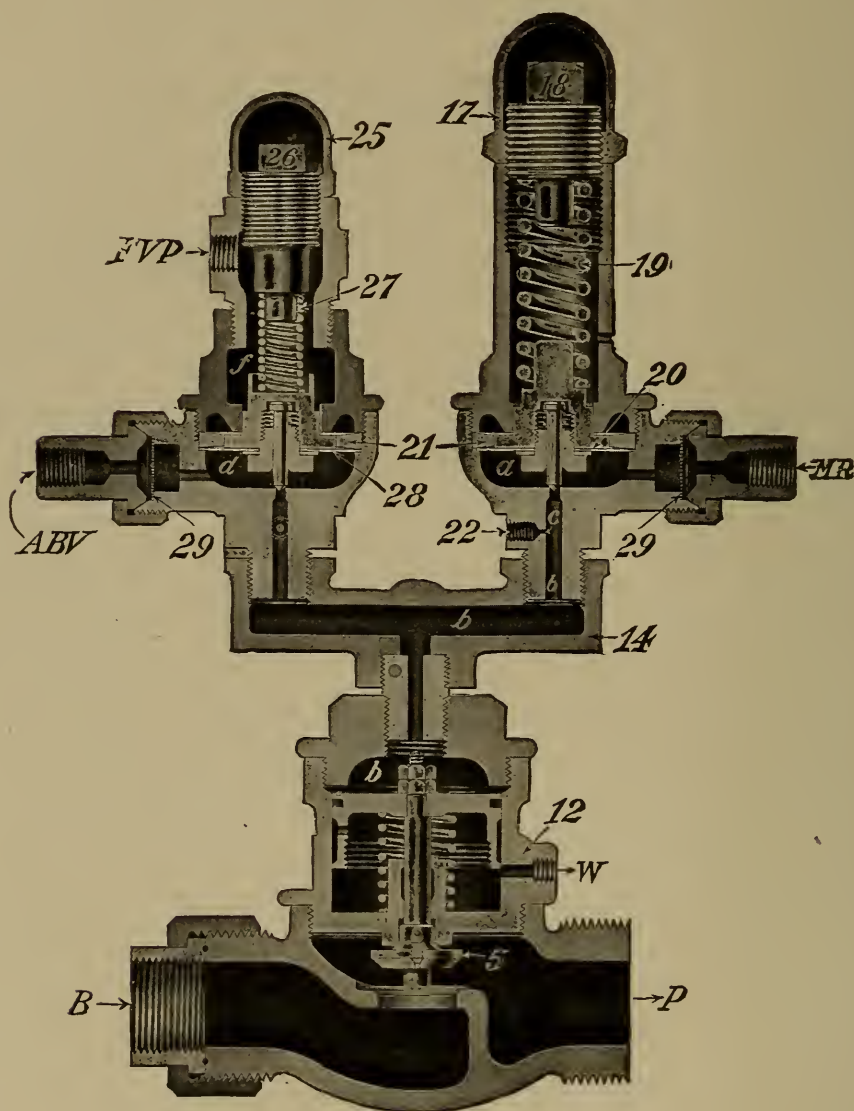


PLATE 94.

sure of regulating spring 27 in holding it down. As this spring is adjusted to about 20 pounds, this diaphragm will be held down until the main reservoir pressure in chamber *d* slightly exceeds

the combined air and spring pressure in chamber *f*. At such time, diaphragm 28 will rise, unseat its pin valve and allow air to flow to chamber *b* above the governor piston, forcing the latter downward, compressing its spring, and restricting the flow of steam past steam valve 5 to the point where the pump will just supply the leakage in the brake system. When main reservoir pressure in chamber *d* becomes reduced, the combined spring and air pressure above the diaphragm forces it down, seating its pin valve.

As chamber *b* is always open to the atmosphere through the small vent port *c*, the pressure in chamber *b* above the governor piston will then escape to the atmosphere and allow the piston spring and steam pressure below valve 5 to raise it and the governor piston to the position shown. Since the connection from the main reservoir to chamber *d* is open only when the handle of the automatic brake valve is in release, running or holding position, in the other positions this governor head is cut out. The connection marked MR in the maximum pressure head should be connected to the main reservoir cut-out cock, or to the pipe connecting the two main reservoirs, in order to be always in communication with the main reservoir, so that when the excess pressure head is cut out by the brake valve, or by the main reservoir cut-out cock, this head will control the pump. When main reservoir pressure in chamber *a* exceeds the tension of spring 19 in the maximum pressure head, diaphragm 20 will raise its pin valve and allow air to flow into chamber *b* above the governor piston, controlling the pump as above described. The adjustment of spring 19 thus forms the maximum limit of main reservoir pressure, as, for example, when the train brakes are applied.

As each governor head has a vent port *c*, from which a small amount of air escapes whenever pressure is present in port *b*, to avoid an unnecessary waste of air, one of these should be plugged.

Adjustment. To adjust the excess pressure head of this governor, cap nut 25 should be removed and adjusting nut 26

turned until the compression of spring 27 gives the desired difference between main reservoir and brake pipe pressures, the handle of the automatic brake valve being in running position. To adjust the maximum pressure head, cap nut 17 should be removed and adjusting nut 18 turned until the compression of spring 19 causes the pump to stop at the maximum main reservoir pressure required, the automatic brake valve now being in lap position. Spring 27 should be adjusted for 20 pounds excess pressure, and spring 19 for a pressure ranging from 120 to 140 pounds, depending on the service required.

THE "DEAD ENGINE" FEATURE.

The "dead engine" feature shown on Plate 70 is for the operation of locomotive brakes when the pump on a locomotive in a train is inoperative, through being broken down or by reason of lack of steam. Plate 95 shows the combined strainer, check valve and

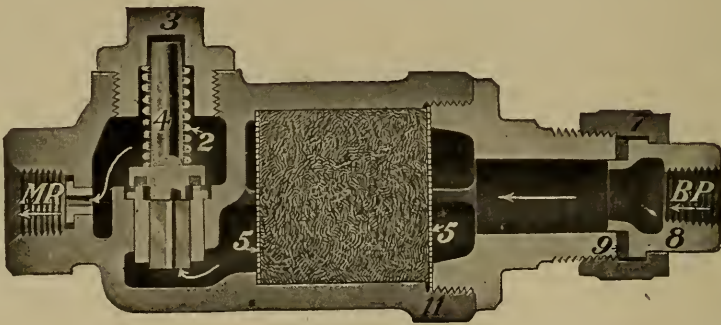


PLATE 95.

choke fitting. As these parts are not required at other times, a cut-out cock is provided. This cock should be kept closed except under the conditions just mentioned. The air for operating the brakes on such a locomotive must then be supplied through the brake pipe from the locomotive operating the train brakes.

Operation. With the cut-out cock open, air from the brake pipe enters at BP (Plate 95), passes through the curled hair strainer 5, lifts check valve 4, which is held to its seat by spring 2, passes through the choke bushing, and out at MR to the main reservoir, thus providing pressure for operating the brakes

on this locomotive. The double-heading cock should be closed, and the handle of each brake valve should be in running position. Where absence of water in the boiler, or some other reason, justifies keeping the maximum braking power of such a locomotive lower than the standard, this can be accomplished by reducing the adjustment of the safety valve on the distributing valve. It can also be reduced at will by the independent brake valve.

The strainer protects the check valve and choke from dirt. Spring 2 over the check valve insures this valve seating and, while assuring an ample pressure to operate the locomotive brakes, keeps the main reservoir pressure somewhat lower than the brake pipe pressure, thereby reducing any leakage from the former. The choke prevents a sudden drop in brake pipe pressure and the application of the train brakes, that would otherwise occur with an uncharged main reservoir cut into a charged brake pipe. In this it operates similarly to the feed groove in a triple valve.

PUMP FAILURE WHEN DOUBLE-HEADING WITH ET EQUIPMENT.

When double-heading, and the air pump is out of order on the second engine, the brakes on this engine could not be operated from the leading engine, as the pressure used for applying these brakes comes from the main reservoir of the second engine. The distributing valve on the second engine would operate, as the pressure chamber would be charged from the leading engine; consequently these valves would respond to reductions in brake pipe pressure made by the leading engine. The brakes on the second engine would not apply, however, on account of lack of air in the main reservoir, which should pass to the brake cylinder when the distributing valves are operated.

The engineman of the second engine can, however, in cases of pump failure, gain control of his engine brakes by placing the automatic brake valve handle in full release position and slowly turning the cut-out cock underneath the brake valve, allowing the main reservoir to charge from the brake pipe, providing the

engine is not equipped with the "dead engine" feature. When the main reservoir is charged to brake pipe pressure, the cut-out cock should be returned to its former position in order to allow the proper operation of the train brakes.

An additional provision is made for charging the main reservoir of the second engine from the leading engine. A few extra parts are furnished, by means of which the main reservoir can be charged through a by-pass, containing a non-return check valve, strainer, cut-out cock and a diaphragm, which necessitates a flow of air from the brake pipe in such a manner that the air taken from it will not apply the train brakes while the main reservoir is being charged.

THE NEW YORK AIR BRAKE and SIGNAL SYSTEM.

The following important parts of the New York Air Brake and Signal System differ from the corresponding parts of the Westinghouse System in its duplex air pump, governor, engineer's valve, compensating valve, quick action triple valve, air signal valve and train pipe strainer. The parts that are identical in both systems of equipment are as follows: The brake cylinders and pistons in all details, the main and auxiliary reservoirs, pressure retaining valves, reducing valves for the air signal system, brake pipe and hose couplings, angle and cut-out cocks and conductor's valves.

THE DUPLEX AIR PUMP.

The No. 5 pump was designed and perfected to meet the demand for a pump that would furnish air for a freight train consisting of 100 cars and still be sufficiently within its capacity to reduce the liability of failure to a minimum. To meet these requirements such structural changes were made as were necessary to improve the design and increase the efficiency and economy of the duplex pump.

Valve Gear. The valve gear of the duplex air pump is exceedingly simple, consisting of two ordinary D slide valves, similar to the same type of valve used on locomotives, actuated by valve stems which extend into the hollow piston rods of the steam cylinders, and are moved by contact with the tappet plates bolted on the steam piston heads. The valve on one side controls the admission of steam to, and exhaust from, the opposite cylinder, so that while one of the pistons is moving the other is at rest. This feature also allows the air valves to seat by gravity.

Air Cylinders. The air cylinders are known as the high and low pressure cylinders, and in each type of pump the difference

in the areas of the air cylinders is in the same proportion, the low pressure piston having twice the area of the high pressure piston, and the latter having the same area as the steam cylinders. Thus

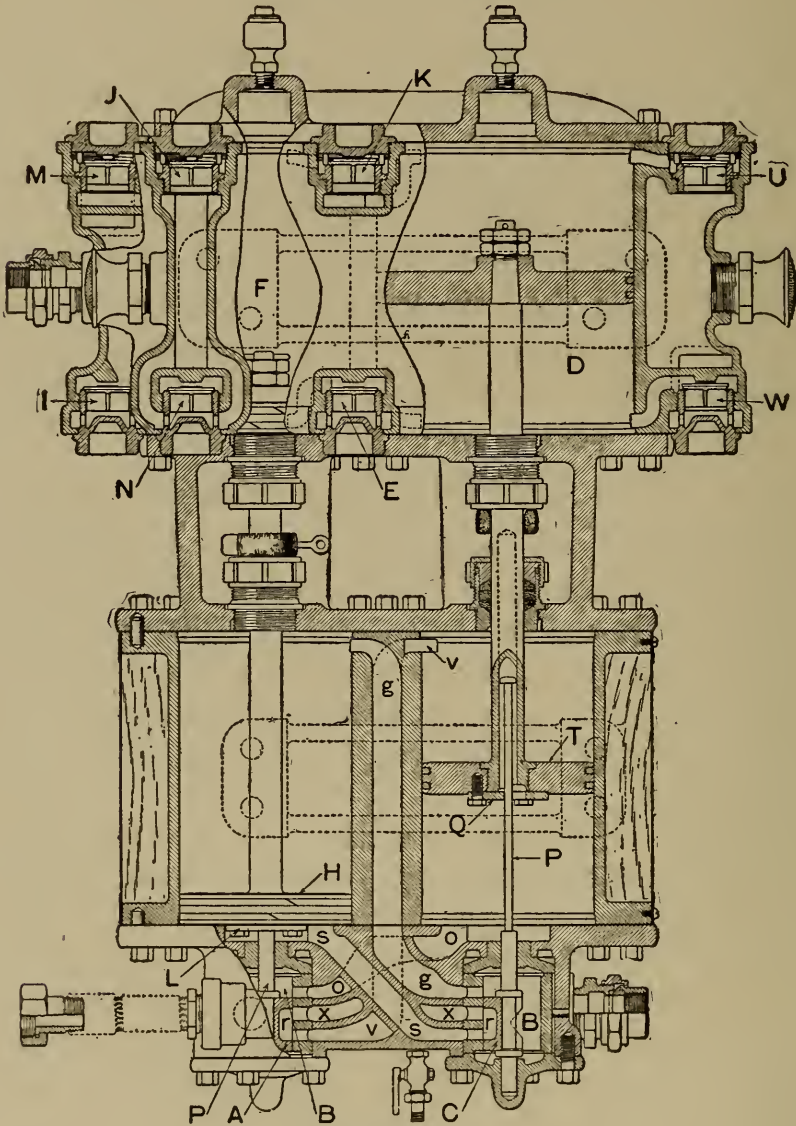


PLATE 96.

three measures of air are compressed with two measures of steam.

Air Valves. The operation of all the duplex air pumps is practically the same, the difference being in the arrangement of the air valves. The No. 1 and No. 2 have six air valves, viz:

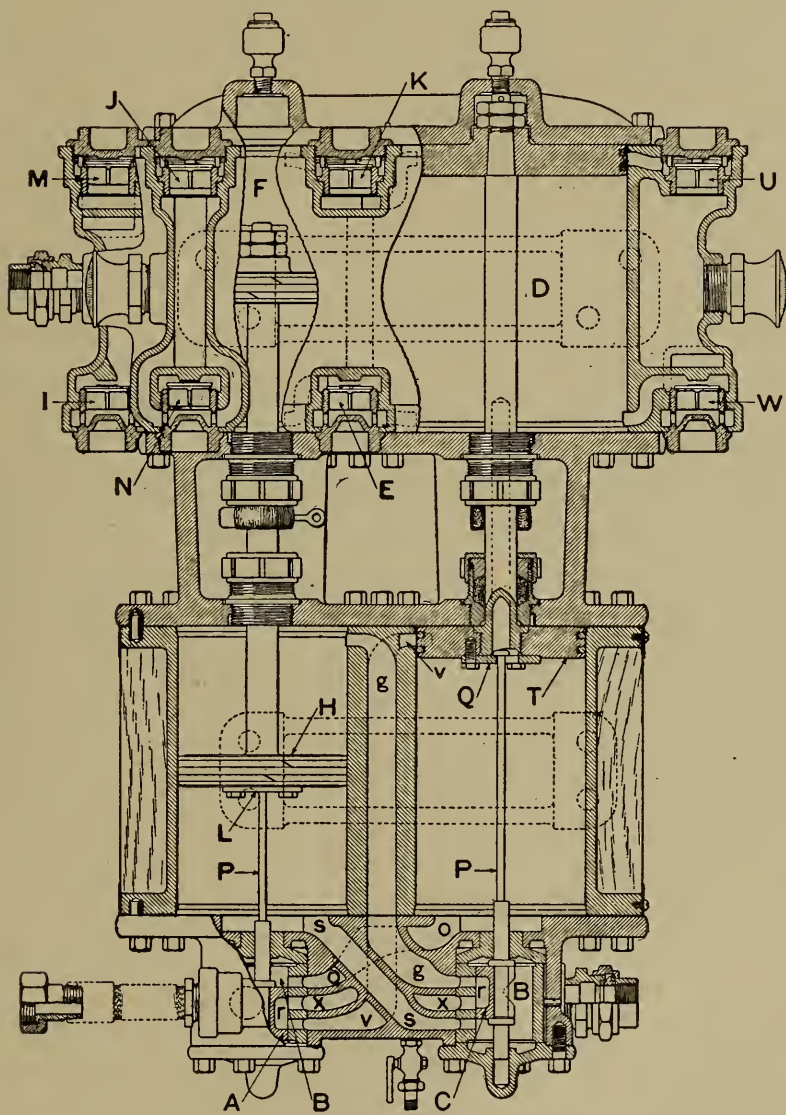


PLATE 97.

Upper and lower receiving, upper and lower intermediate, upper and lower discharge valves, and the same air inlets for both cylinders. The No. 5 and No. 6 pumps have separate air inlets for

each cylinder and eight air valves, viz: Upper and lower receiving for low pressure cylinder, upper and lower intermediate, upper and lower receiving for high pressure cylinder and upper and lower discharge valves. The air valves of the No. 5 pump are alike in size and are interchangeable. This is also true of the valves of the No. 6 pump.

The No. 5 and No. 6 pumps are identical except in size, and as this type of pump is the later one the operation of the No. 5 will be described.

Positions of Pistons. By referring to Plates 96, 97, 98 and 99 it will be seen that each part has a reference letter and that the pump pistons are shown in different positions. Letters will be used in the description of the operation, so that the movements can easily be followed by referring to the plates when reading the explanation.

Operation. Before the pump has been started, both pistons will naturally be at the bottom of the cylinders, due to their own weight, or, if not completely down, will at least have dropped enough to permit the slide valves to fall to the bottom of the steam chests.

Assuming that the pistons are both down when the pump throttle is opened, live steam flows into both steam chests B, and is always present in them when the pump is taking steam. In this instance only, steam is admitted to both cylinders at once through port *g* to the upper side of piston H, which being at the bottom is merely held in that position, and through port *o* to the under side of piston T (Plate 96). Piston T now moves upward and in doing so forces the air that is above the piston in low pressure cylinder D through intermediate valve K, into the high pressure cylinder F. At the same time the low pressure piston tends to create a vacuum under it, which is filled with air at atmospheric pressure through the air inlet at the right and receiving valve W. Just before piston T reaches the end of its upward stroke the tappet plate Q engages the button on the end of valve stem P, which moves slide valve C to its highest position, allow-

ing the steam above piston H to pass through port *g*, cavity *r* in slide valve C and exhaust X to the atmosphere, and live steam through port *s* to the under side of piston H. As piston H moves

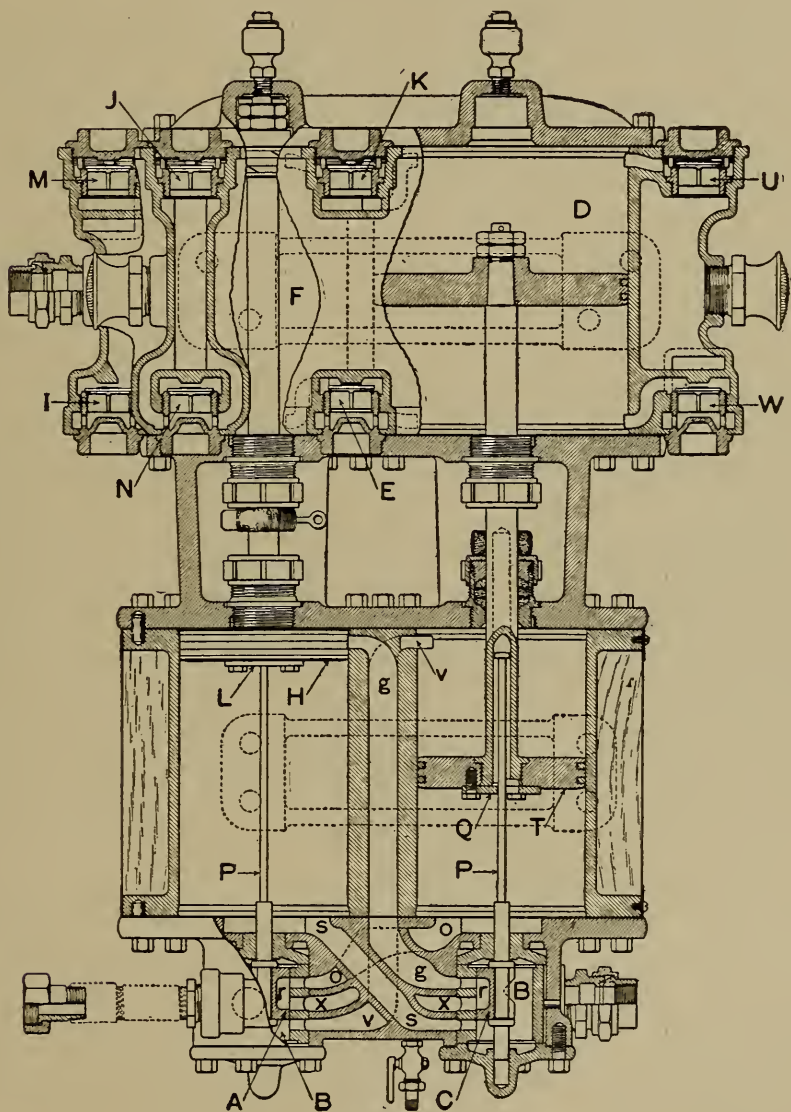


PLATE 98.

upward (Plate 97), the high pressure piston in cylinder F forces the air above it (which may be said to be in the first stage of com-

pression) through discharge valve M to the main reservoir, while its upward movement tends to create a vacuum under it in the high pressure cylinder F, which is filled with air at atmospheric pressure through high pressure receiving valve N.

Just before piston H completes its upward stroke (Plate 98), tappet plate L engages with the button on the valve stem, raising it with slide valve A, exhausting the steam under piston T, through *o*, cavity *r* in slide valve A and exhaust X to the atmosphere, and admits steam through ports V to the upper side of piston T, moving it downward. During the downward movement of piston T the low pressure piston in cylinder D forces the air under it, which was taken in on its upward stroke, through intermediate valve E to the under side of the piston in high pressure cylinder F, and at the same time cylinder D is filled with air at atmospheric pressure through the air inlet and upper receiving valve U. Just before piston T completes its downward stroke (Plate 99), tappet plate Q, coming in contact with the lower tappet or shoulder on valve stem P, moves slide valve C to its lowest position, allowing the steam under piston H to exhaust to the atmosphere through port *s*, cavity *r* in slide valve C and exhaust X, and admits live steam to the upper side of piston H through port *g*, moving it downward. As piston H moves downward the high pressure piston forces the air under it through lower discharge valve I into the main reservoir, while the cylinder is filled above with air at atmospheric pressure through the air inlet at the left and receiving valve J.

The completion of this stroke completes one cycle of the pump. The movements described are repeated through each succeeding cycle.

The air valves, through which air is being received or discharged during the movements of the pistons, are shown in the illustrations as being raised from their seats.

Lubrication. The steam cylinders should receive a constant supply of oil from the lubricator (about one drop per minute), keeping all joints between the lubricator and the pump perfectly

tight to prevent waste. Oil will leak away at the steam joints where there is little or no indication of steam leakage.

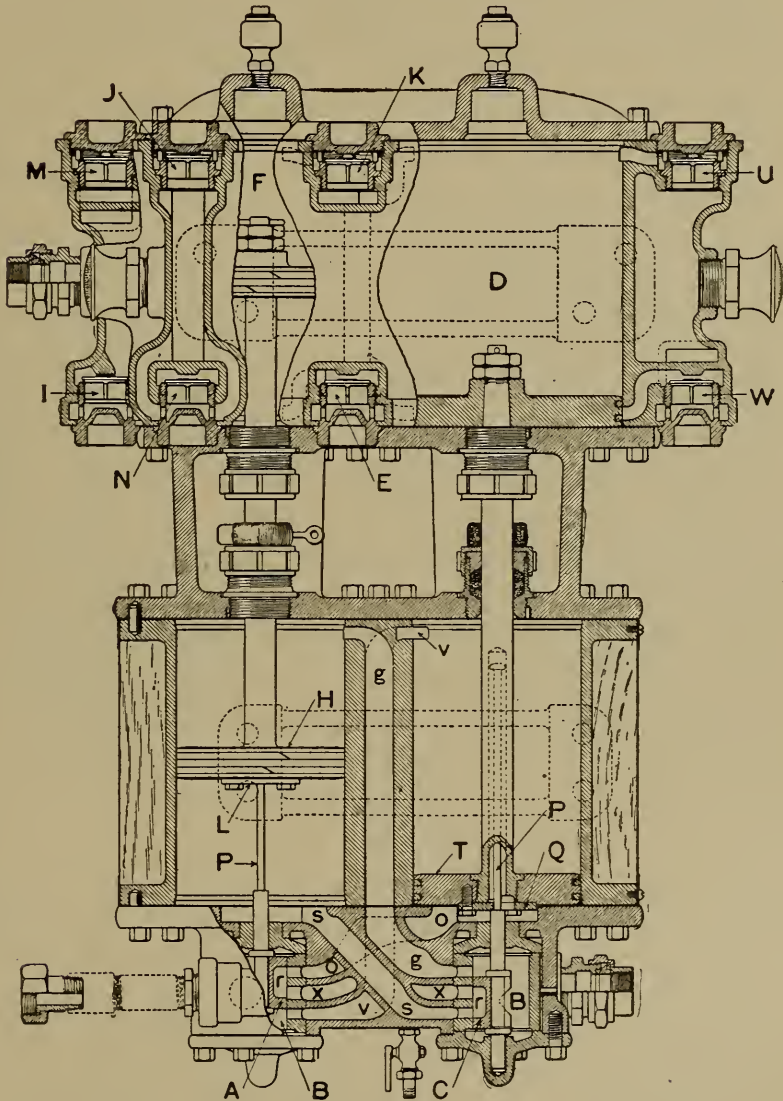


PLATE 99.

The piston rods should be kept well packed and good, clean, well-oiled swabs should be maintained on them.

AUTOMATIC OIL CUP.

Styles A and B of the automatic oil cup, which will lubricate an air cylinder at an even rate, are shown on Plate 100. In the style A cup the quantity of oil fed to the air cylinder is governed by the diameter of the hole drilled in the feed cap OC 15, and can be regulated by changing the size of the hole or substituting a new piece drilled with a different size hole. Style B operates on the same plan and only differs from style A in that it has, in addition to the regulating ports in cap OC 14, an adjustable needle feed OC 17 for regulating the quantity of oil supplied.

Operation. The principle of operation of the automatic oil cup is as follows: As the air piston makes its upward stroke compressed air is driven upward through the passage drilled through the center post in the body of the oil cup, passes downward inside the extended sleeve of the cap nut, and through the regulating ports drilled in this sleeve to the surface of the oil in the reservoir, on which it creates pressure. As the air piston makes its downward stroke a vacuum is formed in the passage in the center post and also inside the extended sleeve of the cap nut which envelops the center post, and the air pressure on the surface of the oil, formed when the air piston made its upward or downward stroke, forces the oil to the inside of the sleeve and a small portion of it is drawn into the air cylinder through the hole in the feed cap OC 15, or needle feed OC 17 which screws into the center post.

The automatic oil cup supplies oil to the air cylinders only when the air pump is working, so that it performs the service required of it effectively, with a maximum economy in the use of oil. Its use will increase the life of the air cylinders, packing rings and piston rod packing, as well as prevent hot pumps and the annoyance caused by the accumulation of gum in other parts of the engine equipment, due to the imperfect, wasteful and uneven lubrication of the air cylinders heretofore in vogue.

The oil cup should be filled before starting on a trip. Good cylinder oil should be used for this purpose, as other oils are

not satisfactory for lubricating air cylinders on account of their low flashing point. The air pump should never be oiled through the air inlets, as it tends to gum and clog the valves and passages. The automatic cup can be filled whether the pump is running or not, but it is a good plan to start the pump first, in order to be sure that the small port in feed cap OC 15 is open. Care should

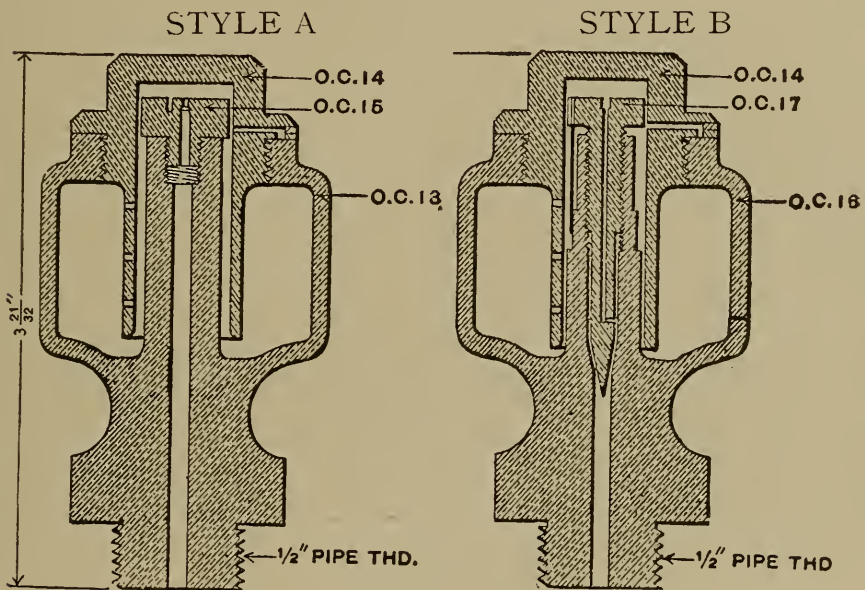


PLATE 100.

be exercised not to enlarge this port when cleaning the oil cup.

Starting the Pump. Before a pump is started the drain cocks in the steam and exhaust passages should be opened. The steam valve should be opened slightly at first and the pump run very slowly until all the water of condensation has been worked out of the steam cylinders, and there is a pressure of 35 or 40 pounds accumulated in the main reservoir, as all locomotive air pumps depend on the air pressure in the main reservoir cushioning the air pistons to prevent them from striking the cylinder

heads. If a pump is started at a high rate of speed the pistons will pound and become loose.

Speed of Pump. The pump should be run at a rate of speed that is just sufficient to maintain the maximum pressure in the main reservoir and overcome the brake pipe leakage, and oil should be fed to the cylinders according to the work they are doing.

No more air is compressed when the pump is run at a high speed than at a moderate one, as the air valves must have time to seat. The pump will do better work at a moderate speed of not over 60 double strokes per minute.

Inspection. Before leaving the roundhouse with the engine the engineman should know that the piston rod packing does not leak, that there are no unusual knocks or pounds, that the steam exhausts are regular and that the air compressing capacity of the pump is normal.

DEFECTS OF THE DUPLEX AIR PUMP.

Pump Piston Rod Packing. If the piston rod packing blows out, the oil will be blown from the rod and swabs. If the air end of the high pressure rod packing leaks it will cut down the capacity of the pump, and the air cushion, which the pump should have to prevent the piston from striking the head, will escape. If it is the piston rod packing on the steam end that leaks it will permit a waste of steam from the steam cylinders and a large portion of this waste steam will be taken in at the lower air receiving valves, thus increasing the quantity of water which will accumulate in the main reservoir.

Pump Pounding. If a pump pounds it is due to the loss of the air cushion at the completion of a stroke; air cylinder packing leaking; too high steam pressure and racing of the pump; loose reversing plates on the steam piston heads; a badly worn button head on the end of valve stem; the pump being loose on its bracket fastenings; brackets loose on the boiler; back leakage through the final discharge valve, or racing the pump against low main reservoir pressure.

Pump Stopping. .When the pump stops of its own accord before maximum pressure has been attained the pump governor should be carefully examined to see that the relief port (the small port above the governor piston in the diaphragm body) is open. If a constant blow of air is found at this small port it indicates that the governor is at fault, and it should be examined and repaired.

If the governor is in perfect order the steam head of the pump should be jarred lightly, and if this does not start the pump the air pump throttle should be closed and the waste cock on the steam chest of the pump opened, allowing all steam to escape, after which the pump throttle should again be opened.

If, after making the throttle test, the low pressure piston moves up and stops at the upper end of its stroke, and the high pressure piston refuses to move, the trouble should be looked for in the steam reversing gear on the right or low pressure side, as valve stem P may have become broken or reversing plate O become worn through. But if the high and low pressure pistons move up, and the low pressure piston fails to move down, it indicates that the valve stem is broken, the reversing plate worn through on the high pressure side, or that the nuts on the air piston are loose, which would also prevent the pump from reversing.

If the pump stops on account of a piston working off, the piston will strike hard on the air end. By removing the oil cups the loose nut can be located by running a piece of wire through the oil cup. If the top head is removed the nut can be put back on the rod or removed entirely from the cylinder.

Sometimes a pump will stop for want of sufficient lubrication, and when this occurs it can be started by shutting off the steam for a few moments, opening the drain cock in the steam passage and again turning on the steam, regulating the lubricator to feed a few extra drops of oil. If this does not overcome the difficulty it is probably due to a breakage, which will have to be repaired in the shop or roundhouse, as engines are not usually provided

with the tools and necessary parts to make such repairs on the road.

Uneven Exhausts. If the exhausts are irregular it is due to the leakage of air from the main reservoir back into the high pressure cylinder, leakage from the high pressure to the low pressure cylinder, or an air valve stuck to its seat.

When the exhaust sounds in two pairs, one pair spaced well apart and the other pair very close together, it indicates that an intermediate air valve (E. K.) or a cylinder head gasket is leaking at a point between two cylinders. This would permit the air from the high pressure cylinder to pass over into the low pressure cylinder, instead of being forced into the main reservoir. As a result, when the low pressure piston takes steam it has both steam and air pressures to cause it to make a quick stroke, which brings two steam exhausts very close together.

When the spaces between three exhausts are nearly equal and those between the third and fourth exhausts are very long it indicates that a discharge valve is broken, the upper air cylinder gasket is leaking badly between the final discharge valve cavity and the air cylinder, or that the lower intermediate valve seat is loose and has worked up sufficiently to raise the intermediate air valve against its seat.

If either of the steam piston heads becomes disconnected from the rod it will cause a stoppage of the pump. This trouble will be indicated by a hard steam blow at the exhaust, making the same sound as a blower turned on full.

Leakages. Back leakage from the low pressure air cylinder through the air inlet valve can be tested for by holding the hand over the strainer while the low pressure piston is moving toward either receiving valve; if they leak, air will blow past them to the atmosphere at the strainer.

Leakage past intermediate valves E and K can be detected by the earlier movement of the low pressure piston away from the defective valve, and the weak intake of air at the inlet valves

U or W (upper or lower), as the case may be, and also by the heating of the pump.

Leakage past the final discharge valves M and I in the high pressure cylinder can be detected by the slower movement of both the low and the high pressure pistons toward the leaky valve, and the quicker movement of the high pressure piston away from it.

To test for worn piston packing rings the pump should be run at a moderate speed against the maximum main reservoir pressure. If, on either the up or down stroke, air is drawn in lightly for the first part of the stroke and the suction ceases as the piston nears the end of its stroke, it indicates a leakage past the packing rings. To locate the defective piston it should be noted which one in making its stroke fails to draw in air properly. Leaky rings in the high pressure cylinder can be located in the same manner.

Blows. A blow will occur in the steam end of the pump if the ends of the reversing rods in the cap nuts are worn, the main slide valve or its seat cut or defective so that steam can escape to the exhaust passage, the packing rings in the steam piston worn or broken, or the cylinder worn.

If the tapped rods are worn so that steam can pass through them into the cap nuts it will return through the passage drilled in the rods to the lower end of the steam cylinder and cause a blow in the lower end of the piston in which it is working. If the slide valves or their seats are leaking or cut, steam can escape through the slide valve chamber into the exhaust, and a constant blow will be produced. If the packing rings on the steam piston are worn or broken, steam will pass by them from one side to the other and escape through the exhaust opening.

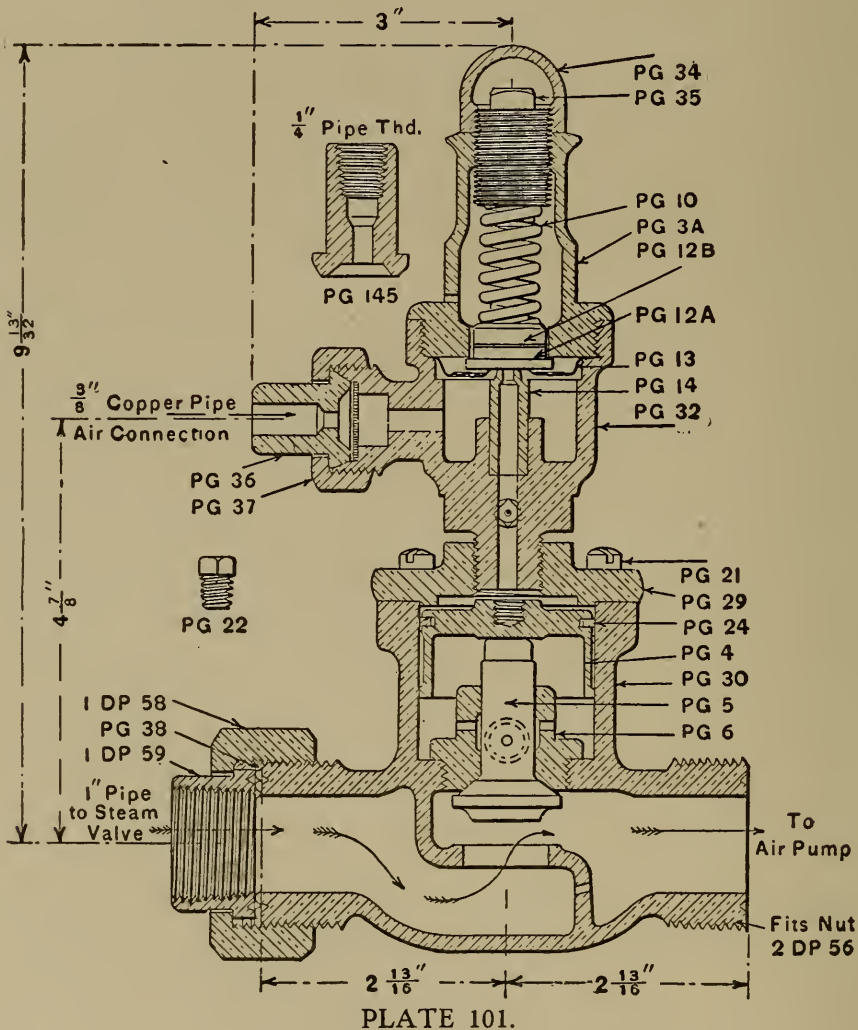
Pump Heating. If the pump runs hot it is due to a leak past the piston rod packing, a leaky intermediate discharge valve, leaky receiving valves, badly worn packing rings in the air end, or racing the pump under high steam pressure.

To cool the pump a small quantity of valve oil should be used in the high pressure air cylinder, and if the pressure can be maintained the pump should be run slowly until cooled.

NEW YORK AIR PUMP GOVERNORS.

STYLE "C" PUMP GOVERNOR.

The function of the pump governor is to stop the pump when the maximum pressure has been attained and to allow steam to be again admitted to the pump when this pressure has been slightly



reduced, thus maintaining practically a constant pressure.

The pump governor is shown with the steam valve open on

Plate 101 and closed on Plate 102; the arrows indicate the direction of the flow of steam and air.

Operation. When sufficient air pressure, the amount for which the governor is adjusted, accumulates in the diaphragm air

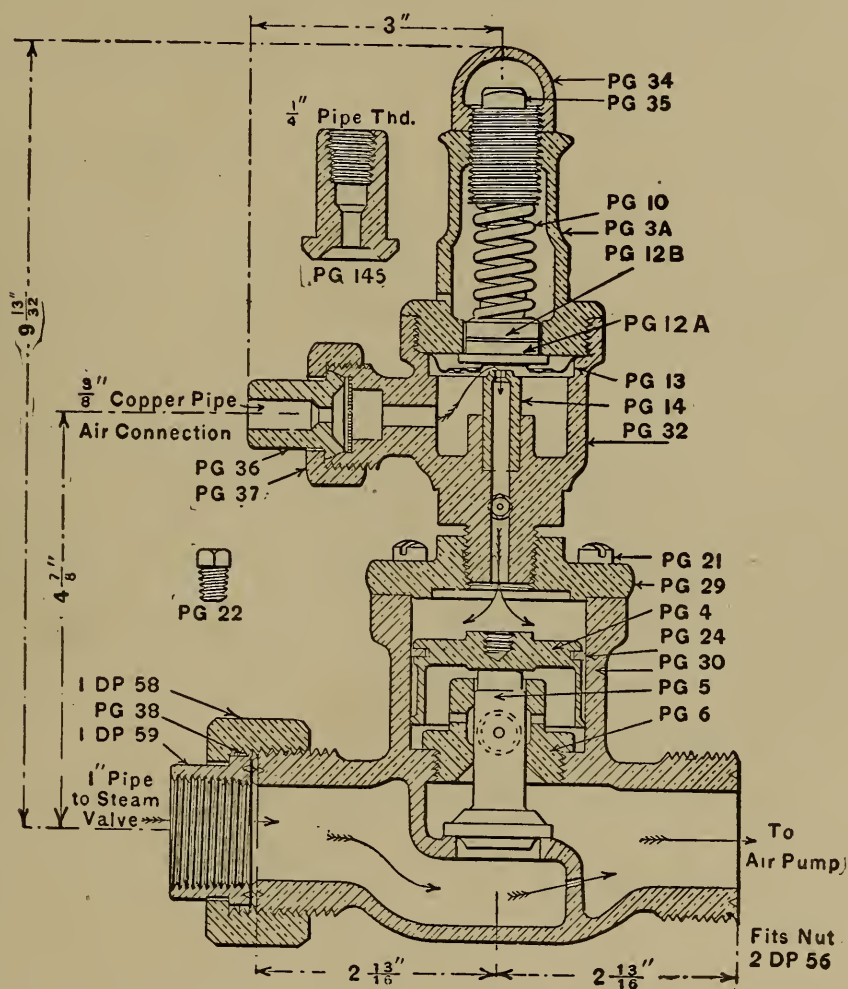


PLATE 102.

valve chamber to overcome the resistance of regulating spring PG 10, the diaphragm air valve PG 13 is lifted, uncovering the air passage in its seat PG 14, and air flows down on top of piston PG 4, which rests on top of steam valve PG 5; then the piston and steam valve together are forced downward until the steam

valve seats, as shown on Plate 102, and closes the steam passage leading to the air pump, thus cutting off the supply of steam. This action takes place when the air pressure for which the governor is adjusted has been obtained.

When the air pressure in the diaphragm air chamber falls below the tension of the regulating spring, diaphragm air valve PG 13 seats, as shown on Plate 101, and cuts off the flow of air to governor piston PG 4.

The remaining air pressure in the governor piston chamber is quickly reduced by escaping through the small vent port, indicated by the small dotted circles, in the air passage connecting the diaphragm air valve and the governor piston air chambers; then the steam pressure acting upwardly on the face of steam valve PG 5 forces this valve open and admits steam to the pump.

DUPLEX PUMP GOVERNOR.

The duplex pump governor (Plate 103) differs in construction from the single governor in that it has two pressure tops connected by means of a "siamese" fitting to a single body. It is used for the single pressure system, the same as the single governor, and also for what is known as the double pressure, or high pressure control system.

Adjustment. The pump governor is adjusted to regulate the amount of air pressure carried by means of regulating spring PG 10. By screwing down adjusting nut PG 35, the tension of this spring is increased, and by screwing up the nut it is decreased.

Increasing the tension of the spring increases the air pressure that may be carried, and decreasing the tension decreases the pressure.

The adjusting nut should be screwed down until the pump stops at the desired pressure, and the promptness with which the pump starts when the air pressure reduces should be noted. If the pump does not start promptly the adjusting nut should be

screwed up a trifle and again screwed down if the required pressure is not maintained, after which the cap nut should be replaced securely.

When adjusting the pump governor care should be taken to ascertain that the air gauge is correct. Often when trouble is experienced in adjusting governors the trouble is due to the erratic action of the air gauge.

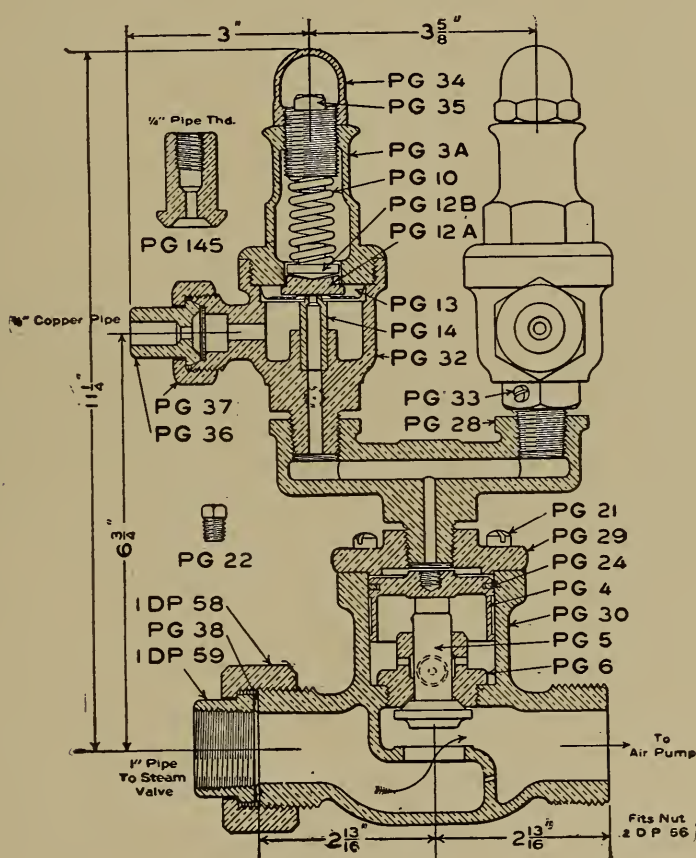


PLATE 103.

DEFECTS OF THE PUMP GOVERNOR.

If the governor has been properly adjusted and, without any change of adjustment, gradually increases the amount of pressure, the trouble is probably due to the accumulation of gum on the face of the diaphragm air valve PG 13, where it seats over

the air passage PG 14, thereby increasing the length of the port and reducing the lift of the diaphragm.

The following defects will not allow the governor to shut off the steam when the maximum air pressure is obtained: The regulating spring may be adjusted too tightly; too much oil used in the air end of the pump, causing the valve to gum up on its seat; air leaking by the governor piston as fast as it passes into the passage over the piston; the governor piston sticking so that the air pressure cannot force the piston down. If the waste pipe in the steam end of the governor is stopped up so that steam or air accumulates below the piston the governor will not shut off at any pressure, and if there is a leak by the diaphragm with the hole in the spring casing stopped up it will prevent the governor from operating.

If the governor stops the pump and fails to release it promptly, when the air pressure in the main drum has been reduced sufficiently, it indicates a leakage past the diaphragm air valve, permitting air to flow down onto the governor piston, which would tend to hold the steam valve closed and would prevent it from opening promptly. This defect is indicated by a constant flow of air from the small relief port in the diaphragm body above the governor piston.

When the governor is correctly adjusted, and it fails to reduce the speed of the pump when the standard pressure has been accumulated, it may be due to the closing of the lower drainage port leading from the under side of the governor piston to the atmosphere, the diaphragm air valve leaking around its edge into the spring casing with the relief port in the casing clogged, or the port leading from the diaphragm seat to the top of the governor piston closed with gum. The accumulation of gum at this point is caused by dirt and other foreign matter finding its way into the governor and lodging on the seat of the diaphragm valve. Excessive quantities of poor oil used in the air cylinders and pumps that run hot also contribute to the accumulation of gum at this point.

THE B3 LOCOMOTIVE BRAKE EQUIPMENT.

The locomotive brake equipment described and illustrated herein is known as the B3 equipment, and is arranged in four different schedules to cover the general requirements of railroad service.

Schedule B3 is for engines in passenger or freight service where but one brake pipe pressure is used. Both the pump governor and the pressure controller have single regulating heads, which should be adjusted for the standard brake pipe and main reservoir pressures (Plate 104).

Schedule B3-S is for switch engines only. A single pump governor and a single pressure controller are used. The controller is set to give a brake pipe pressure of 70 pounds and the pump governor for 90 pounds main reservoir pressure for ordinary switching service. However, when the engine is used for passenger switching service, and handles trains that are using 110 pounds brake pipe pressure, the pump governor should be adjusted to 110 pounds main reservoir pressure. When handling trains using high pressure, cock No. 2 between the regulating and supply parts of the controller should be closed. This renders the controller inoperative and allows the main reservoir pressure of 110 pounds to pass to the brake valve and brake pipe, so that trains using the high speed brake can be handled without delay and without the necessity of additional apparatus. A quick release valve is furnished with this schedule and is to be placed in the straight air pipe so that the brakes can be released quickly, permitting quicker movement. The divided reservoir and the accelerator valve are not furnished with this schedule. The supplementary reservoir is substituted for the divided reservoir (Plate 105).

Schedule B3-HP is for freight service where heavily loaded trains are handled on heavy grades, or loads handled down grades and empties up grade. Both regulating portions of the pump governor and the pressure controller are duplex, so that pressures of

70 and 90 pounds can be carried in the brake pipe, and 90 and 110 pounds in the main reservoir, for the ordinary brake pipe pressure and the high pressure control.

Three-way cocks are provided for the operation of these duplex regulating parts, being connected as shown in the piping diagram (Plate 106). To operate these cocks the handle should be turned in line with the pipe leading to the regulating head to be used, high or low pressure, as desired. This will cut in the head to regulate the supply portion and cut off the pressure to the one not in use.

Schedule B3-HS is the high speed brake. It includes the duplex pressure controller and the duplex pump governor. The regulating heads of the pressure controller should be adjusted to 70 and 110 pounds for brake pipe pressure, and the pump governor heads adjusted to 90 and 130 pounds for main reservoir pressure. A union four-way cock is used with the regulating heads of the pressure controller. This is a special cock with a connection to each regulating top, one to the supply pipe between the controller and brake valve and one to the pipe connecting the brake valve and accelerator reservoir. When the handle of the four-way cock is in position to operate the regulating head adjusted to 110 pounds brake pipe pressure, a small port in the accelerator reservoir connection is brought into communication with a port to the atmosphere. The object of this port is to prevent more than the usual predetermined reduction of brake pipe air obtained in the graduating notches taking place with 110 pounds pressure. A union three-way cock connected to the main reservoir and pump governor regulating tops is used to change the main reservoir pressure (Plate 107).

Piping Diagrams. Plates 104, 105, 106 and 107 show the piping diagrams of the four schedules of the B3 equipment, and also the several parts comprising each schedule, as well as the proper pipe connections. This equipment is an improvement over former equipments. It not only includes all necessary features for the automatic brake, but also a straight air brake for

the locomotive and tender, all operated by the automatic brake valve without any additional positions.

Improvements in the B₃ Brake Valve. Among the improvements incorporated in the B₃ brake valve are, the use of tap bolts instead of screws to fasten the valve cover to the body, and port o is cored in the valve body instead of being drilled through the cover. The projection for centering the piston packing leather EV 107 is on the piston instead of on the follower. A new packing leather can therefore be applied without removing the piston from the brake valve, it only being necessary to remove the back cap and the piston follower.

Other parts of the equipment fully described under their different headings are: The 1¼-inch pressure controller, by which the brake pipe pressure is regulated; the accelerator valve, which assists the brake valve in discharging brake pipe air when making service applications with long trains; the ¾-inch controller, which controls the straight air brake pressure; the high speed controller, which acts as a reducing valve for the driver and truck brake cylinders; the lever safety valve, and the quick release valve.

MANIPULATION.

To apply the automatic brakes on the locomotive and train, the handle of the brake valve should be moved to the graduating notch necessary to make the desired brake pipe reduction.

To release both locomotive and train brakes, the handle should be moved to running and straight air release position.

To release the train brakes and hold the locomotive brakes set, the handle should be moved to automatic release and straight air application position.

To apply the locomotive brakes (straight air), the handle should be moved to full automatic release and straight air application position.

To release the locomotive brakes, the handle should be moved to running and straight air release position.

To apply the brakes in an emergency, the handle should be

moved quickly to emergency position and left there until the train stops.

In case the automatic brakes are applied by the bursting of a hose, the train parting, or the conductor's valve is opened, the handle should be placed in lap position in order to retain the main reservoir pressure.

To graduate off or entirely release the locomotive brakes while holding the train brakes applied, the lever safety valve should be used to make the required reduction.

The handle of the brake valve will be found to work freely and easily at all times, as the pressure on the main slide valve does not exceed the maximum brake pipe pressure.

The cylinder gauge will show at all times the pressure in the locomotive brake cylinder and should be observed in brake manipulations.

Double-Heading. When there are two or more locomotives in a train, cut-out cock No. 1 should be turned to close the brake pipe and the brake valve carried in running and straight air release position on all locomotives, except the one from which the brakes are operated.

Cutting Out the Straight Air Brake. If it becomes necessary to cut out the straight air brake, cut-out cock No. 3, located in the straight air pipe, should be closed.

Cutting Out the Automatic Brake on the Engine. To cut out the automatic brake on the engine, cut-out cock No. 6, located in the pipe connecting the triple valve and the double check valve, should be closed. By locating the cut-out cock at this point the auxiliary reservoir will remain charged if the brake is cut out, and it can be cut in immediately if so desired. This cut-out cock and also cut-out cock No. 3 are special; they are of the three-way pattern and when turned off drain the pipes leading to the double check valve, which insures the check valve remaining seated in the direction of the closed cock.

Cut-Out Cock No. 4. Main reservoir cock No. 4 is for the

purpose of cutting off the supply of air when removing any of the apparatus, except the governor.

Straight Air Controller. The function of the straight air controller is to limit the pressure in the driver, truck and tender brake cylinders for the straight air brakes. It should be adjusted to withstand a pressure of 40 pounds.

THE B₃ BRAKE VALVE.

List of Parts. Plates 108, 109, 110 and 111 show the different parts of the brake valve as follows:

QT 3. Piston Ring.	EV 183. Piston Cotter.
QT 29. 1-inch Union Bolt.	EV 192. Cap Gasket.
QT 30. 1-inch Union Swivel.	EV 196. Lever Shaft Plug.
QT 31. 1-inch Union Gasket.	EV 199. Back Cap Stud and Nut.
EV 60. Small Union Nut.	
EV 75. Handle Pin.	EV 301. Follower.
EV 77. Handle Set Screw.	EV 302. Graduating Valve Lever.
EV 96. ¼-inch Plug.	
EV 103. End Plug.	EV 303. Link.
EV 107. Packing Leather.	EV 304. Slide Valve Lever.
EV 108. Expander.	EV 305. Lever Shaft.
EV 111. Graduating Valve Spring.	EV 306. Quadrant Screw.
	EV 307. Cover Gasket.
EV 113. Fulcrum Pin.	EV 309. Body.
EV 121. Lever Shaft Packing.	EV 310. Back Cap.
EV 123B. Handle.	EV 311. Piston.
EV 128. Small Union Stud.	EV 312. Main Slide Valve.
EV 158. Union Swivel.	EV 313. Valve Cover.
EV 165. Lever Shaft Nut.	EV 314. Quadrant.
EV 172. Quadrant Latch.	EV 315. Cover Bolt.
EV 173. Latch Screw.	EV 316. Link Pin.
EV 175. Link Pin Cotter.	EV 317. Graduating Valve.
EV 180. Vent Valve.	EV 323. Nut Lock Bolt.
EV 181. Follow Cap Nut.	EV 325. Nut Lock Spring.
EV 182. Vent Valve Spring.	EV 610. Handle Spring.

Plate 108 is a longitudinal side section of the brake valve (running position), showing the main slide valve EV 312 and how the graduating valve EV 317 is controlled by piston EV 311 and lever EV 302; also port O in the back cap, closed by the vent valve EV 180. This view also shows the different positions of the brake valve handle. Plate 109 is a cross section through the

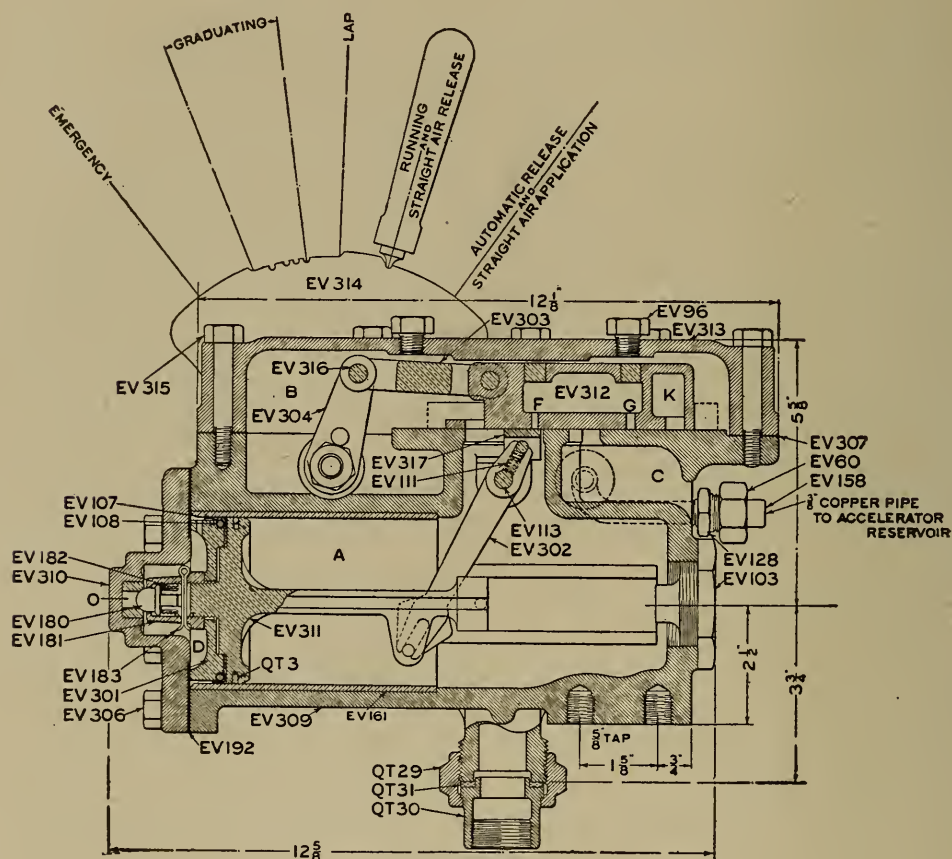


PLATE 108.

valve (rear view). Plate 110 is a cross section through the main slide valve EV 312. This view shows the main reservoir and brake pipe connections; it also shows the location of passage H, which connects the supplementary reservoir and chamber D, back of piston EV 311; also port O drilled to the slide valve seat, and cavity R in the slide valve. Plate 111 is a top view of the

valve with the cover, slide valve and handle removed, showing the seat and connections for the straight air and divided reservoir pipes. A shows the opening through the slide valve seat to brake valve chamber A beneath the slide valve; B is a cavity back of the slide valve seat into which the air flows from the main reservoir pipe, although all the space under the valve cover and

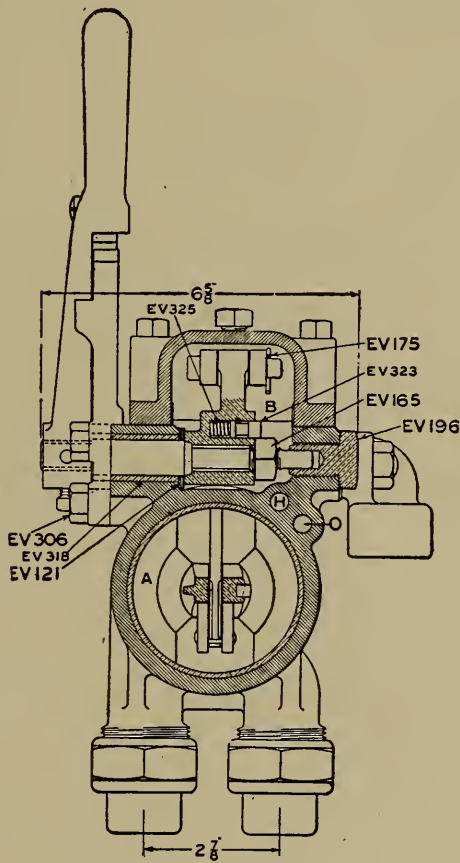
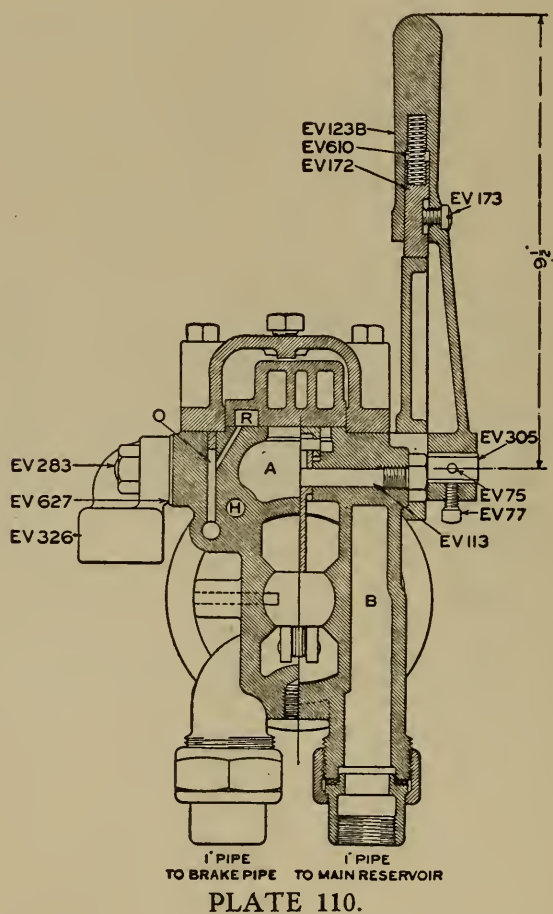


PLATE 109

above the slide valve is known as chamber B; G is the exhaust passage; V is a port in the seat through to the exhaust passage and is an exhaust port for the straight air brake in running and straight air release positions, and is also an exhaust port for the air from chamber D through port O in the release, running and

lap positions; port T leads to the accelerator reservoir; port W leads to passage H and the supplementary reservoir. The location of port O in the seat is also shown.

Port O is used for the purpose of venting air from chamber D to the atmosphere, so as to permit piston EV 311 to return to its normal position (Plate 108) when releasing brakes. It runs



from the vent valve seat through the back cap, lengthwise through the body of the brake valve to a point shown on Plate 109 and thence up to the seat of the slide valve. It is connected to the exhaust passage by cavity R in the slide valve and port V in the seat in full release, running and lap positions.

Chamber D air is prevented from escaping to the atmosphere in these positions by vent valve EV 180 on the end of piston EV 311. Just before the slide valve reaches the first graduating notch it covers port O, so that when the piston moves forward to automatically close the service exhaust port F, chamber D air only gets to the face of the slide valve. When the brake valve is placed in full release, running or lap position, air from chamber D flows through port O, cavity R and port V to the atmos-

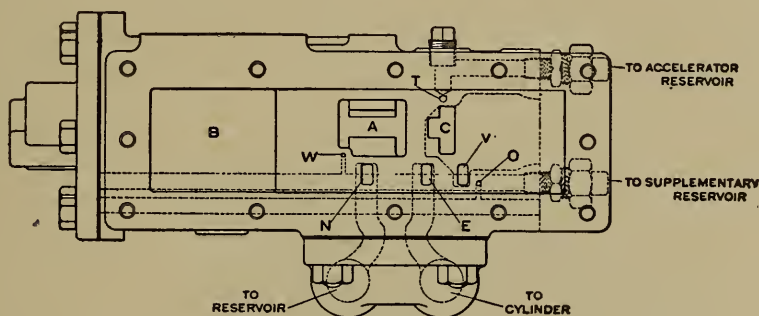


PLATE 111.

phere, until the pressure in chamber D is slightly below that in chamber A (brake pipe), when the brake pipe pressure, being the greater, forces piston EV 311 to the position shown on Plate 108, seating the vent valve and preventing further escape of air from chamber D.

Pipe Connections. EV 326 is a pipe bracket bolted to the side of the brake valve. It has two pipe connections, one to the main reservoir and the other to the brake cylinders. Dotted lines show the cored passage from the main reservoir connections to port N, and from port E to the cylinder pipe connection.

Slide Valve. Plate 112 shows the face of the slide valve. F and G are the service exhaust ports, and are connected by a passage through the center of the slide valve; J and K are the emergency exhaust ports connected by passages on each side of the central passage connecting F and G; S is a small port connected by passage X to the elongated port Ac, which registers with port T in the seat in all the service application positions; P is a

groove and its function is to connect port W and the supplementary reservoir with brake pipe pressure in release and running positions; L is a passage through which air passes from the main reservoir pipe to the brake cylinder pipe in a straight air application position; R is a cavity connecting ports E and V in running and straight air release positions to release the straight air brakes, and connects ports O and V in release, running and lap positions.

It also permits the partial opening of port N to E in the last graduating notch and full opening in emergency position. Ports M are through the slide valve and are for the purpose of charging the brake pipe.

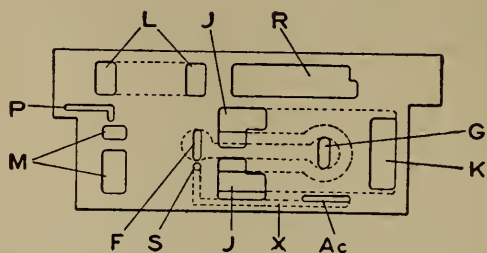


PLATE 112.

Course of Main Reservoir and Brake Pipe Air. Main reservoir air, reduced to brake pipe pressure by the pressure controller, flows into chamber B. The slide valve EV 312 controls the flow of air from the main reservoir to the brake pipe and from the brake pipe to the atmosphere. The brake pipe is connected to chamber A. Discharge of brake pipe air to the atmosphere for service applications occurs through ports F and G and exhaust passage C but, for emergency application, through ports J and K and exhaust passage C. In full automatic release position, air is free to flow from the main reservoir to the brake pipe through ports M and past the end of slide valve EV 312. In running position, ports M only are open between the main reservoir and the brake pipe, but they are sufficiently large to permit the release of the train brakes. Small slide valve EV 317 is a cut-off

or graduating valve, operated by piston EV 311 and lever EV 302. In service applications it automatically laps port F and stops the discharge of brake pipe air, when the brake pipe reduction, corresponding to the service graduating notch in which the handle is placed, has been made. Piston EV 311, which is exposed on one side to brake pipe pressure and on the other to chamber D or supplementary reservoir pressure, through the agency of lever EV 302, causes valve EV 317 to move automatically whatever distance is necessary to close port F.

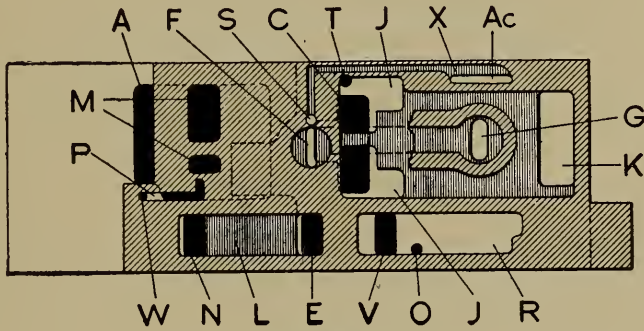


PLATE 113.

Automatic Release and Straight Air Application Position.

Plate 113 shows automatic release and straight air application position. The purpose of this position is to promptly release the automatic brakes and to apply the straight air brakes or retain the pressure in the locomotive and tender brake cylinders. In this position air flows directly from chamber B (main reservoir) into chamber A (brake pipe), past the end of the slide valve and through ports M. Port O is open to the atmosphere through port V to permit piston EV 311 to return to its normal position. Port T is open to the atmosphere through J and C. The supplementary reservoir is being charged to brake pipe pressure through groove P and port W from chamber A. Port E is brought into communication with port N by passage L, permitting air to pass to the locomotive and tender brake cylinders, through the straight air pipe and double check valve, until shut off by the $\frac{3}{4}$ -inch

pressure controller, the regulating top of which is connected to the straight air pipe and is adjusted at 40 pounds. By placing the valve handle about midway between release and running positions the straight air ports can be lapped, making it possible to increase or decrease the brake cylinder pressure as may be desired.

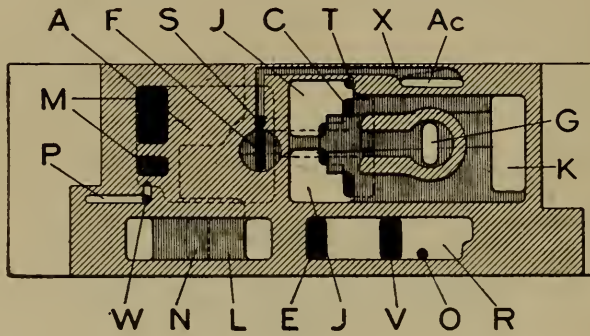


PLATE 114.

Running and Straight Air Release Position. Plate 114 shows the running and straight air release position. This is the position in which to place the handle when wishing to release the train and locomotive brakes simultaneously, or to release the straight air brake when it only has been applied. Air passes from the

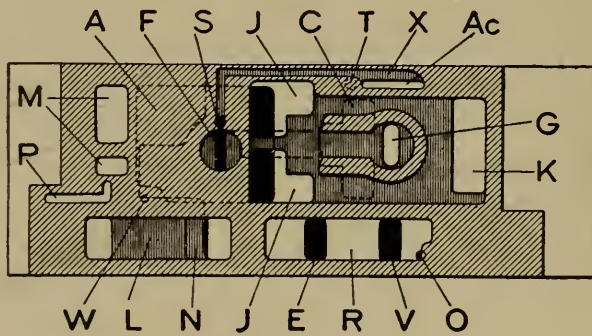


PLATE 115.

main reservoir to the brake pipe through ports M. Port N is closed; port E is brought into communication with port V and the atmosphere by cavity R, releasing the straight air brake; ports O and T are still open to the atmosphere as in full release

position; port T is open to the atmosphere through J and C in release and running positions, so that in case of a release, following a partial application, the accelerator reservoir pressure can escape and prevent the operation of the accelerator valve, while groove P still holds port W in communication with the brake pipe pressure in chamber A.

Lap Position. Plate 115 shows lap position. The brake valve handle should be placed in this position when a hose bursts, a train parts or a conductor's valve is open, for the purpose of saving the main reservoir air. All ports are closed in this position, except port O, which is open to the atmosphere through port V and the exhaust passage in release, running and lap positions.

Service Application. Plate 116 shows service application position. This position is for the purpose of gradually applying

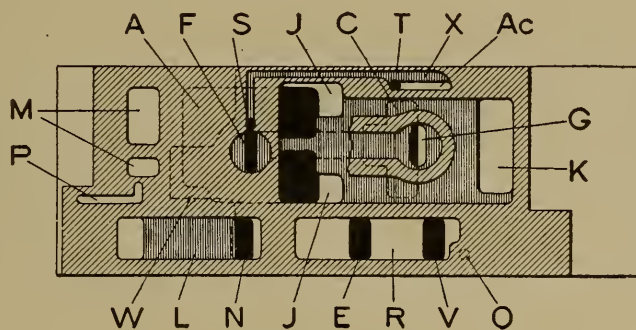


PLATE 116.

the brakes, and is divided into five graduating positions designated by notches on the quadrant. The reduction in brake pipe pressure obtained in the different notches are respectively 5, 8, 11, 15 and 23 pounds. The amount of the initial reduction should always be governed by the length of the train, speeds, grades, etc. The handle of the brake valve should always be placed in the notch which will give the required reduction. When the brake valve is moved to the first graduating notch the slide valve is in the position shown. Port O is closed to prevent the escape of chamber D pressure; port F is moved back of the graduating

valve EV 317, and port G registers with exhaust port C. Brake pipe air now flows to the atmosphere. It also flows through port S, passage X and port T to the accelerator reservoir, building up a pressure to operate the accelerator valve. As soon as the pressure in the brake pipe reduces, the pressure in chamber D, now being the greater, begins to expand to equalize with the brake pipe pressure, and in doing so moves piston EV 311 for-

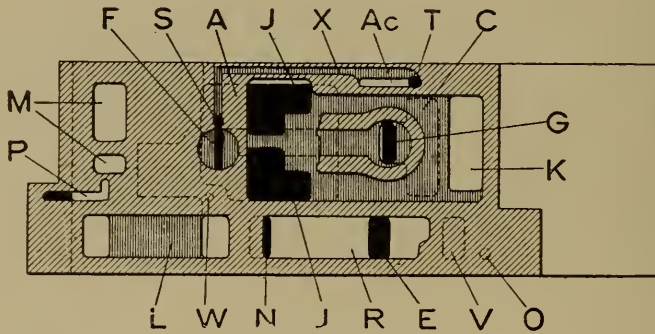


PLATE 117.

ward. The piston carries with it the lower end of the graduating valve lever EV 302, which is so proportioned that the graduating valve EV 317 on the other end of it is moved back just far enough to close ports F and S when the pressures in chamber D and the brake pipe have equalized. This stops the flow of air

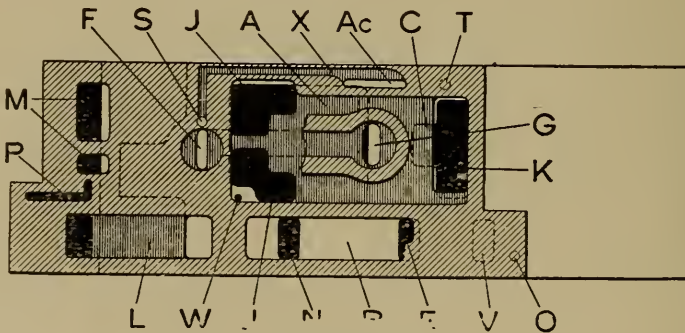


PLATE 118,

from the brake pipe to the atmosphere and to the accelerator reservoir. This action is called automatic lap, and it takes place in all the graduating positions. A further reduction of the brake

pipe pressure is made by moving the brake valve handle back to any of the service notches, the piston moving further forward for each successive reduction. The action of the brake valve is the same and the ports are in the same relation to each other in all service positions of the brake valve, except the last graduating position, shown on Plate 117. In this position a partial opening of port N admits air slowly to the locomotive and tender brake cylinders, through cavity R and port E, up to the adjustment of the controller on the straight air pipe, which will insure full braking pressure on the engine with a full application, regardless of piston travel and brake cylinder leakage.

Emergency Application. Plate 118 shows emergency application position. This position is for the purpose of producing a quick, heavy reduction in brake pipe pressure so that all the triple valves on the train will operate in quick action and apply the brakes in the shortest possible time. Port J registers with chamber A, and K with the exhaust port C, allowing brake pipe air to escape rapidly to the atmosphere. Cavity R allows air from the main reservoir to pass through ports N and E to the locomotive brake cylinders, and the full pressure of the straight air brake is maintained on the engine.

DEFECTS OF THE B₃ BRAKE VALVE.

To test for a main slide valve leak the cut-out cock below the brake valve should be closed, the pump started, and the brake valve handle placed in lap position. All ports are then blanked and any leakage past the slide valve to the brake pipe will be indicated by the black hand of the air gauge. Another method of making this test is to make a full service application when the brake system is charged. This reduction would cause a difference between the brake pipe pressure and that on top of the slide valve, and if there were any leak by the slide valve it would be indicated by the brake releasing and the raising of the black hand of the air gauge. Still another method of testing would be to place the brake valve in either graduating notch when the brake

system is charged, and if the escape of air at exhaust passage C did not entirely stop and the black hand of the air gauge did not fall at the same time, it would indicate that the main slide valve were leaking.

To test for a leaky graduating valve, after the brake system is fully charged, the brake valve should be placed in the first graduating notch. If the blow continues at exhaust port C, venting the air from the brake pipe to the atmosphere, it indicates a leaky graduating valve.

If the packing ring on the equalizing piston leaks it can be detected by having the full pressure in the brake system, turning the cut-out cock below the brake valve and placing the brake valve in emergency position. If air escapes from port C until the supplementary reservoir is drained, it indicates a leak at the packing ring.

If the vent valve leaks it will be indicated by a constant blow from exhaust port C when the brake valve is in full release, running or lap position.

SUPPLEMENTARY RESERVOIR.

Plate 119 shows a supplementary reservoir used with switch engine equipment, schedule B₃-S. The names of the parts are: EV 60, Small Union Nut; EV 155, Supplementary Reservoir; EV 156, Reservoir Plug; EV 158, Union Swivel.

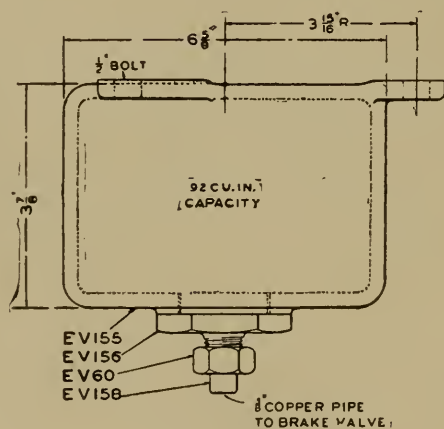


PLATE 119.

The duty of the supplementary reservoir in service application is to hold the air used to move the equalizing piston and graduating valve, and automatically lap the valve in service reductions. Any leakage in the supplementary reservoir or pipe connection, or gasket EV 107, destroys this feature and renders it necessary to place the brake valve handle in lap position after each reduction to prevent all brake pipe air from being lost.

If there is a broken pipe connection leading to the supplementary reservoir it would be necessary to put in a blind gasket between the brake pipe and the joint, and place the brake valve handle in lap position after each reduction.

DIVIDED RESERVOIR.

Plate 120 shows the divided reservoir (side and end view) used with schedule B₂ and B₃. When the accelerator valve is being used, the small compartment is used for chamber D pressure and the large compartment for the use of the accelerator valve. The end view shows where the accelerator valve is attached.

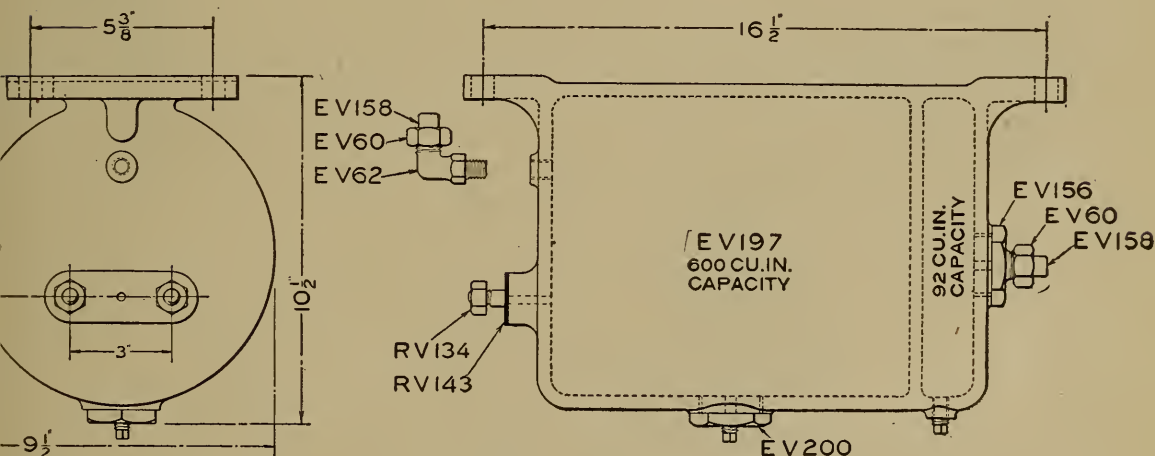


PLATE 120.

PRESSURE CONTROLLER.

The pressure controller is in reality a part of the brake valve, taking the place of the excess pressure or feed valve, and is connected to the main reservoir pipe near the brake valve for the

purpose of controlling the brake pipe pressure. The regulating and supply portions are separate, being connected by piping, and the regulating heads connect directly to the pipe between the supply portion and the brake valve.

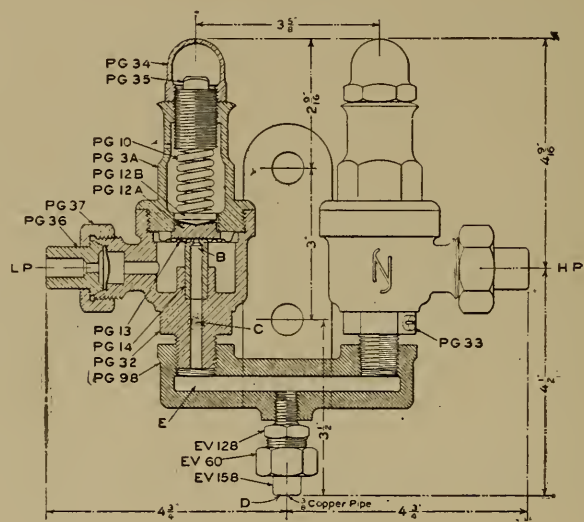


PLATE 121.

With the pressure controller the excess pressure is confined to the main reservoir and, while it has sufficient capacity to re-

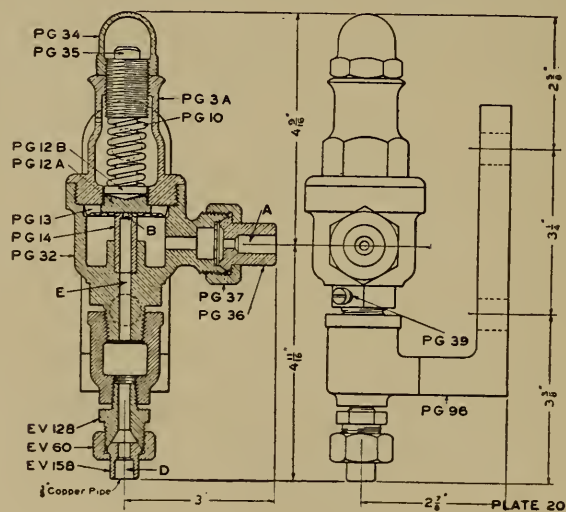


PLATE 122

lease the brakes promptly and recharge the auxiliary reservoirs on a train of any length, there is no danger of overcharging the auxiliary reservoirs on the forward end of the train. Thus, the possibility of a reapplication of the brakes on the forward end of the train is prevented during the charging of the rear brakes.

Styles of Controllers. The controller is made in two styles, single and duplex, to cover the requirements of the different schedules. Plate 121 is a sectional view of a duplex regulating part and Plate 122 a similar view of a single regulating part.

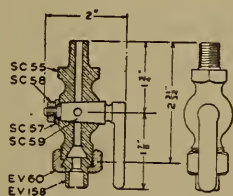


PLATE 123.

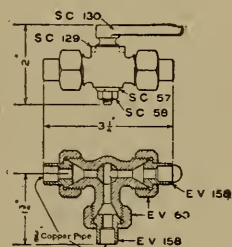


PLATE 124.

Plates 123 and 124 show the three-way and the four-way cut-out cocks, which are used to control the air pressure to the regulating heads. Plate 125 is a sectional view of the supply portion of the controller. By referring to Plate 125 you will

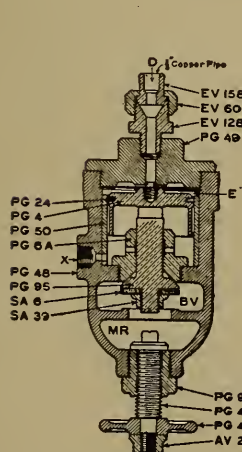


PLATE 125—FIG. 1.

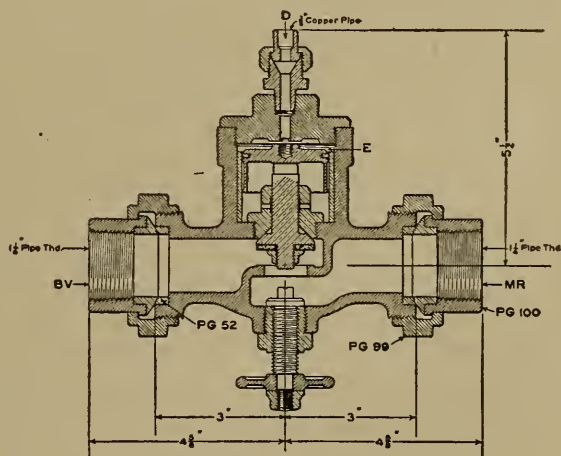


FIG. 2—PLATE 125.

notice that Fig. 1 shows end view and Plate 125, Fig. 2, a cross sectional view. It will be noted that the connection with the main reservoir is made at MR, and by means of the cored passage, air is free to pass to the under side of valve PG 95. Connection BV leads to the brake valve and main reservoir connection, and connection D to the regulating part (single or duplex), also connecting at D on Plate 125, Fig. 2.

Operation. In operation, with either a single or a duplex regulating part, as soon as the pressure in the brake pipe is sufficient to overcome the resistance of spring PG 10, which holds diaphragm PG 13 seated over port B, the pressure will pass through passage E to connection D and through piping to space E in the supply part of the controller above piston PG 4, forcing the piston and valve PG 95 down until seated and cutting off communication between the main reservoir and the brake pipe.

As soon as the pressure in the brake pipe falls below the resistance of spring PG 10 the latter will force diaphragm PG 13 to its seat, closing off port B, whereupon the pressure in passage E and the piping connecting the supply and regulating parts, and space E above piston PG 4, will immediately escape to the atmosphere through small port C in the regulating head of the controller, after which the main reservoir pressure will lift valve PG 95 off its seat and again open communication to the brake valve, thus maintaining a constant pressure in the brake pipe.

Port X in the supply part of the controller connects the under side of piston PG 4 with the atmosphere, so that it will be free to operate and to discharge any leakage past ring PG 24 or valve PG 95.

Regulating Parts. The regulating parts are provided with brackets so that they can be attached to the cab in a position convenient for adjustment. The adjustment of these regulating heads is accomplished by means of nut PG 35, which regulates the tension of spring PG 10.

As each regulating head has a vent port C to avoid waste of

air with all duplex regulating parts, one of these heads should be plugged with a screw PG 33.

Three-Way and Four-Way Cock Connections. By referring to the piping diagram it will readily be seen how the three-way cock is connected with the regulating heads in schedule B3-HP and how the four-way cock is connected to the regulating heads and accelerator reservoir in schedule B3-HS.

Use of Cut-Out Cock. As before stated, the cut-out cock shown on Plate 124 is used with the B3-S equipment between the regulating and the supply parts. When the cut-out cock is closed the supply part of the controller is cut off, making it inoperative, for the reasons given in the previous instructions.

Cutting Out the Controller. The hand wheel PG 45 can be used in case of any defect that causes a sluggish action of the controller. By screwing the wheel up it will lift valve PG 95 off its seat and allow the free passage of air from the main reservoir to the brake valve. The controller will then be inoperative, and main reservoir and brake pipe pressures will be equal until the controller is again put in working condition.

Size of Controller to Straight Air Brake. A $\frac{3}{4}$ -inch controller is used to control the straight air brake pressure. It is located in a $\frac{3}{4}$ -inch pipe, which is attached to the main reservoir pipe between cut-out cock No. 4 and the $1\frac{1}{4}$ -inch controller, and leads to the main reservoir connection of pipe bracket EV 326. The regulating head is connected to the straight air pipe between the pipe bracket and the double check valve. It is adjusted to 40 pounds, and maintains that pressure in the locomotive brake cylinders when the straight air brake is applied. Its operation is identical with that of the $1\frac{1}{4}$ -inch pressure controller.

Double Check Valve. A double check valve is used with this type of equipment, and in all cases it is of the type used with the independent straight air equipment. It is so placed in the pipe connection that when the automatic brake is used the double check moves over and closes communication between the

brake cylinder and the straight air release, and when the straight air is used it moves over and closes communication from the brake cylinder to the triple exhaust. The piping diagram shows the location, and it works upon the same principle as the Westinghouse double check, which is illustrated and described on pages 128 to 129.

DEFECTS OF THE PRESSURE CONTROLLER.

If leather seat SA 6 leaks it will allow the main drum pressure to leak by the valve and overcharge the brake pipe. If the passage leading to piston PG 24 is stopped up, or the tension of spring PG 10 is too great, or if there is a leak by the diaphragm with the vent port in the spring casing stopped up, a leak by piston PG 24, a leak by the stem of valve PG 95 with port X stopped up, or piston PG 24 stuck in the bushing, the brake pipe will become overcharged.

To overcome these defects temporarily, and until repairs are made, the low pressure pump governor of the duplex should be adjusted to shut off the pump at any desired pressure.

If the pipe leading to the single controller, or the pipe leading from the brake valve to the cut-off cock breaks, the pump governor should be adjusted to regulate the required amount of pressure, and the pipe leading to the controller plugged.

If any one of the pipes leading from the reversing cock to the controller top breaks, the reversing cock should be turned, and the other controller top cut in and adjusted to carry the proper pressure.

If the controllers or pump governor require cleaning, and there is pressure in the main reservoir, the pump should be shut off and the reversing cock turned so as to shut off the pressure from the governor or controller that needs cleaning. The tension of the spring should then be slacked off, the air pipe disconnected and the spring box removed, after which the different parts may be cleaned and replaced.

ACCELERATOR VALVE.

It is well known that with the ordinary brake valves alone it is almost impossible, even with a full service application, to set all the brakes on a train of from 75 to 100 cars. This is due to the back flow of air from the auxiliary reservoirs to the brake pipe through the feed grooves, and from the brake cylinder to the atmosphere through the leakage grooves. It is the result of the comparatively slow brake pipe reduction through the service application ports of the brake valve, which for obvious reasons cannot be enlarged.

List of Parts. The names of the parts are as follows:

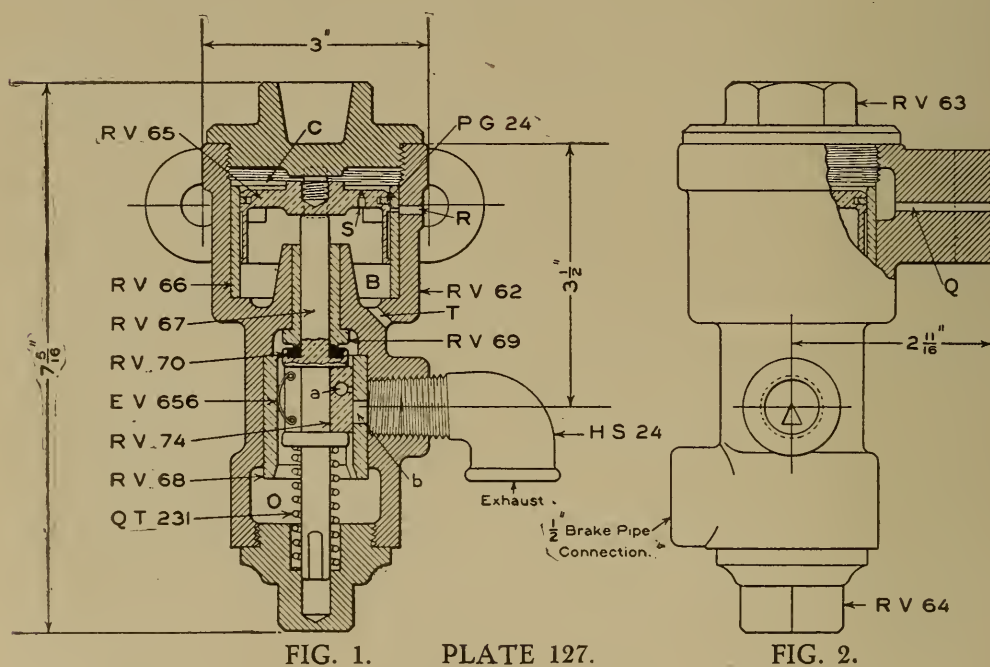
PG 24. Piston Ring.	RV 70. Leather Seat.
RV 62. Body.	RV 74. Slide Valve.
RV 63. Upper Cap.	QT 231. Spring.
RV 64. Lower Cap.	EV 656. Slide Valve Spring.
RV 65. Piston.	HS 24. $\frac{1}{4}$ -inch Street Ell.
RV 67. Valve Stem.	

Purpose of the Accelerator. The purpose of the accelerator valve is to overcome this difficulty. Its duty is to assist the brake valve in discharging brake pipe air when making service reductions with long trains, and to bring about a more uniform and prompt application of the brakes than is possible with the ordinary brake valves. It operates only when a service application is made, and then only when the volume of brake pipe air is sufficient to warrant its use. The reductions, however, are no greater with the accelerator valve than with the former types of brake valve, as the automatic cut-off of the brake valve controls the flow of air that actuates the accelerator. This valve does exactly what its name implies; it accelerates the discharge of brake pipe air. The operation of the accelerator valve is automatic; it opens about 4 seconds after the brake valve handle has been moved to the graduating notch and closes in about the same length of time, after the graduating valve has closed ports F and S in the slide valve. A pressure of from about 10 to 12 pounds in the large compartment of the divided reservoir is required to

operate it; consequently it does not open with a shorter train than one of 8 cars, as with a train of this length the automatic lap of the brake valve takes place before sufficient pressure has been accumulated in the divided reservoir to move the piston of the accelerator valve down against the spring.

The accelerator valve is bolted to the divided reservoir, the large chamber of which is the accelerator reservoir and the small one the supplementary reservoir.

Arrangement of Piping. The arrangement of the piping is shown in the piping diagrams. Plate 127, Fig. 2, is an outside view of the valve, showing the brake pipe connection and exhaust elbow, and Plate 127, Fig. 1, is a sectional view.



Brake Pipe Pressure. Brake pipe pressure is always present in chamber O, around slide valve RV 74, and is prevented from escaping to chamber B by leather seat RV 70, which is held to its seat by spring QT 231. There is an oblong port *a* in the slide valve and a triangular port *b* in the slide valve bushing with its point upward.

Operation. When the brake valve is placed in service position port S in the slide valve is open to the brake pipe, and the long port Ac, which is also in the slide valve, registers with port T in the seat, allowing brake pipe air to pass through ports S and T to the accelerator reservoir and to the top of piston RV 65, which is always in direct communication with the accelerator reservoir. When a pressure of from 10 to 12 pounds is accumulated in the reservoir the piston, valve stem and slide valve are moved down, compressing spring QT 231. Port *a* then registers with port *b*, but, as the small part of the port opens first, the brake pipe air flows slowly to the atmosphere, the discharge increasing as the port opens wider, until the full travel of the piston and slide valve gives a full opening of the port. When the cut-off valve of the brake valve goes to automatic lap and closes port S, air ceases to flow to the accelerator reservoir. The pressure on piston RV 65 reduces through ports R and T in the body of the valve and through port S in the piston. As soon as the pressure above the piston has been reduced sufficiently, spring QT 231 pushes the slide valve and piston upward, first closing port R, then ports *a* and *b*, lastly closing leather seated valve RV 70 and stopping the flow of brake pipe air to the atmosphere. The piston closes port R before the slide valve closes port *b*, so that the air from the accelerator reservoir flowing more slowly through port S in the piston gives the slide valve the slow closure desired.

The action of the accelerator valve allows a much larger volume of air to pass from the brake pipe than could flow in the same time through service ports F and G in the brake valve, and it will remain open longer with a long train than with a short one, as the volume of brake pipe air to be reduced is greater and cut-off valve EV 317 stays open longer.

DEFECTS OF THE ACCELERATOR VALVE.

If there is a leak by slide valve RV 74, due to dirt, scale or the valve being cut, air will continue to flow from the valve, which will have the same effect as a leak from the brake pipe.

If the leak affects the proper operation of the brakes, the valve

should be cut out by turning the cut-out cock; if not equipped with a cut-out cock, a blind gasket should be placed in the pipe leading to the accelerator. The same action should be taken if spring QT 231, or port S in piston RV 65, is stopped up; if port S is stopped up, the pressure cannot escape and therefore holds the piston down. This will allow all brake pipe pressure to be exhausted. When this difficulty is encountered the nut in the pipe leading to the divided reservoir should be slacked up.

If, with a long train, the accelerator valve fails to open at all when a heavy reduction is made, it may be due to the passage in the slide valve leading to the divided reservoir being stopped up, a leak in the pipe connection, a leak by piston packing ring PG 24, which would allow the air to escape too fast without forcing piston RV 65 down, or piston RV 65 becoming stuck in the bushing.

If ports R and S are stopped up it will allow the pressure to equalize on both sides of piston RV 65, preventing the piston from being forced downward. If leather seat RV 70 is worn and does not seat properly, allowing air to leak past it, with ports R and T stopped up, it will have the same effect.

If ports R and T are open, and leather seat RV 70 leaks, there will be a constant flow of air at these ports, which will have the same effect as a brake pipe leak, but will not prevent the valve from operating.

QUICK RELEASE VALVE.

The quick release valve, shown on Plate 128, is for use with schedule B3-S switch engine equipment. This valve is for the purpose of hastening the release after an application of the automatic or straight air brakes. Connection A leads to the double check valve, as shown in the piping diagram of this equipment; connection B leads to the driver brake cylinders, and connection X to the exhaust.

As soon as the brakes are applied by automatic or independent

application, pressure passes to the top of piston RV 142, forcing the latter down against the resistance of spring RV 138, until it strikes the collar on valve RV 141, clearing the valve body sufficiently to give a direct opening to the brake cylinders.

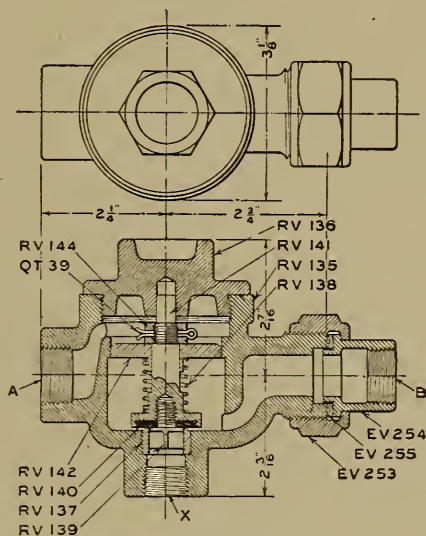


PLATE 128.

In effecting a release, as soon as the handle of the brake valve has been returned to release position, the pressure will be reduced from the upper side of the piston, allowing the pressure on the under side to operate it and lift valve RV 141 off its seat, allowing the discharge of pressure from the brake cylinders to the atmosphere.

While the quick release valve is shown between the double check and driver brake cylinders in the piping diagram it can, if desired, be placed in the straight air pipe between the brake valve and the double check, in order to hasten release of the straight air brakes on the engine and tender, leaving the release of the automatic brakes normal.

List of Operative Parts. The operative parts are as follows:

RV 136. Cap.	RV 140. Valve Seat.
RV 138. Spring.	RV 141. Valve.
RV 139. Valve Guide.	RV 142. Piston.

HIGH SPEED CONTROLLER.

List of Operative Parts. The operative parts are as follows:

RV 103. Regulating Nut.	RV 132. Valve Seat.
RV 104. Cap Nut.	RV 133. Valve.
RV 105A. Regulating Spring.	HS 105. Cap.
RV 129. Lever Handle	HS 107. Piston.
RV 130. Lever Handle Pin with Cotter.	HS 108. Piston Valve.
	SA 6. Leather Seat.
RV 131. Valve Stem.	

The high speed controller is used with schedule B3-HS. Plate 129 is a sectional view of this appliance showing the operative parts, which are as follows: HS 107, Piston, with Valve; HS 108, which is provided with one large and one small Annular Groove; RV 105A, Spring; RV 131, Valve Stem; RV 133, Pop Valve, and RV 129, Lever Handle.

The high speed controller is connected to the brake cylinders at BC and to the brake pipe at BP. Its normal position is as shown in the illustration, where it is held by brake pipe pressure. During all ordinary service applications the piston remains in this position, and the brake cylinder pressure can pass freely to the safety valve, through the large groove, when it is higher than the pressure that the safety valve is set to retain. Ports F and D allow the brake cylinder pressure to circulate around piston HS 107 and back of valve HS 108, which allows them to move with only a slight difference in pressure. However, when an emergency application is made, the brake pipe pressure is greatly reduced, and the brake cylinder pressure forces the piston and valve their full travel to seat C. This movement brings the smaller groove directly under passage G, which restricts the passage of brake cylinder air to the safety valve and causes a

gradual reduction until stopped by the safety valve. The safety valves should be adjusted at 53 pounds, and whether used alone or with the high speed controller are piped to the engine brake cylinders, so that they will relieve the cylinders of all pressure in

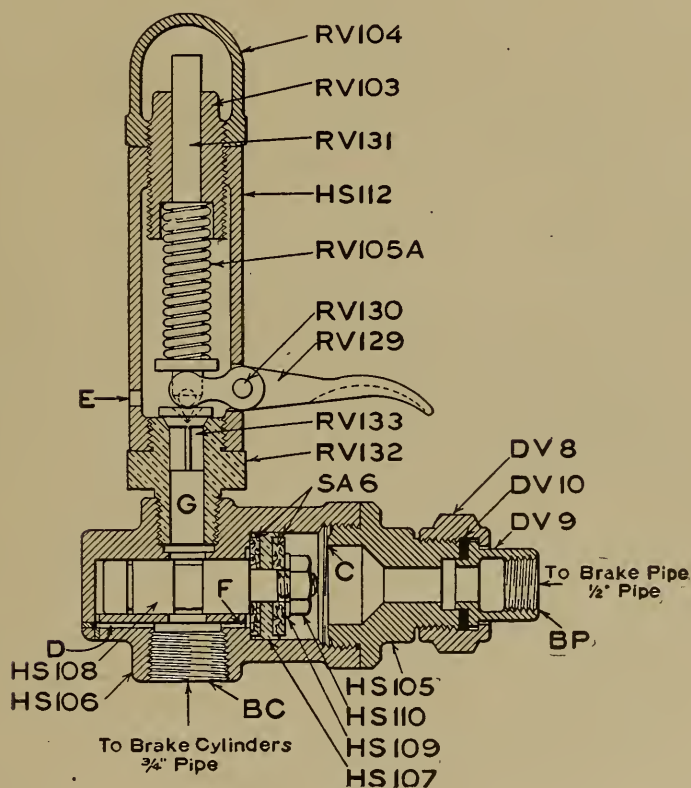


PLATE 129.

excess of 53 pounds, whether obtained with the automatic or straight air application.

LEVER SAFETY VALVE.

Plate 130 is a sectional view of the lever safety valve, furnished with schedules B₃, B₃-S and B₃-HP. The top portion

of this valve is adjusted and operated in the same manner as that of the high speed controller lever safety valve and is adjusted at 53 pounds.

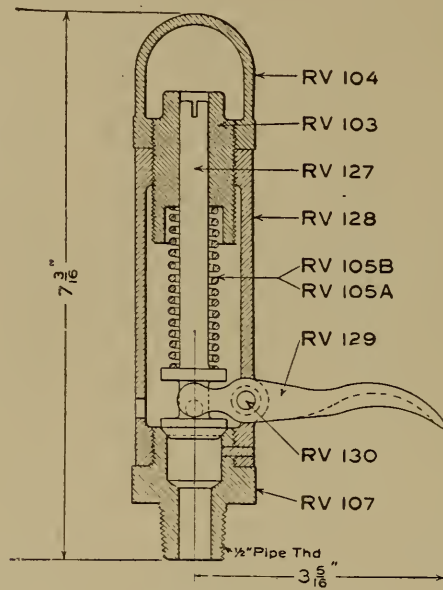


PLATE 130.

List of Operative Parts. The operative parts are as follows:

RV 103. Regulating Nut.	RV 127. Valve.
RV 105A. Regulating Spring.	RV 129. Lever Handle.
RV 107. Valve Seat.	

NEW YORK QUICK ACTION TRIPLE VALVES.

This triple valve is called a quick action triple for the reason that when an emergency application is made it carries auxiliary reservoir air to the brake cylinder almost instantly, equalizing

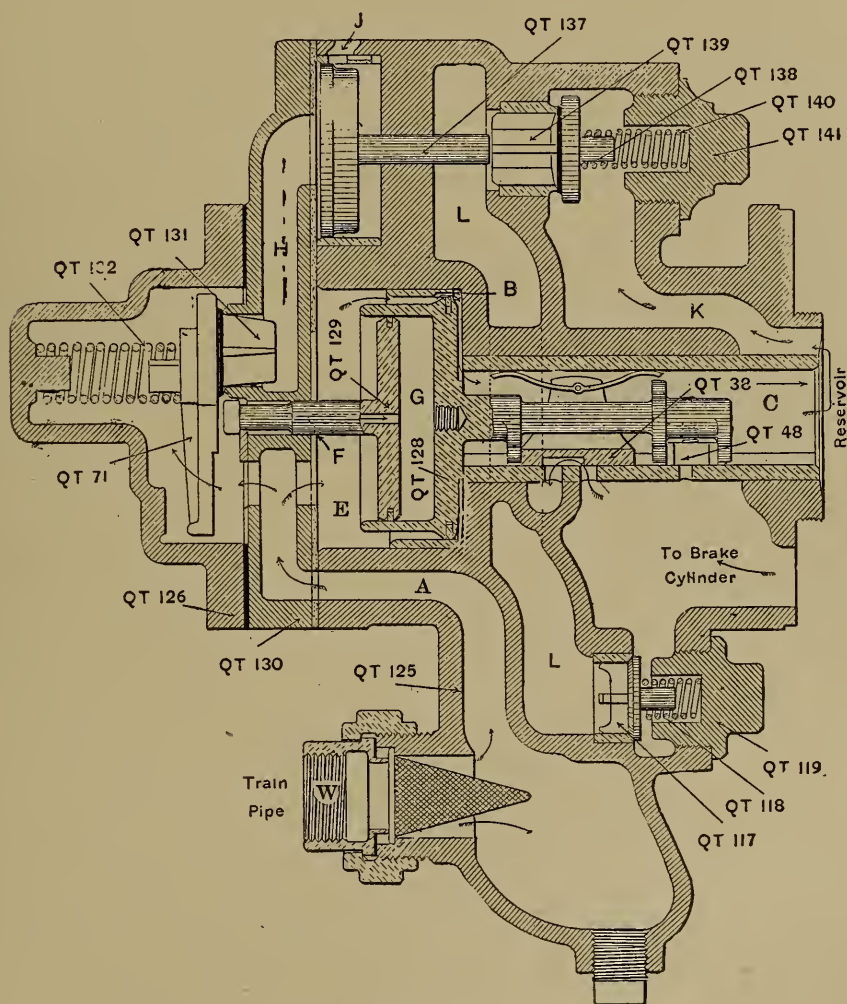


PLATE 131.

the pressure through the large opening, past the quick action valve, augmented to some extent through the service opening past the graduating valve and, by reason of venting brake pipe

268 NEW YORK QUICK ACTION TRIPLE VALVES.

air to the atmosphere, it produces a quick serial action of all other quick action triples throughout the train.

When a service application is made air passes slowly from the auxiliary reservoir to the brake cylinder, through the graduating service port only, and there is no local venting of brake pipe air.

The quick action triple valve, as shown respectively in release, service, lap and emergency positions on Plates 131, 132, 133 and 134, is used on freight cars. Port F of this triple valve is drilled through the stem, the same as it is on the new passenger triple valve.

List of Parts. The parts of the quick action triple valve shown on Plates 131 to 136 inclusive are as follows:

QT 3. Packing Ring.	QT 126. Triple Head or Cap.
QT 9. Exhaust Valve Spring.	QT 130. Middle Section of Flange and seal for Vent Valve.
QT 20. Rubber Seating on Valve QT 71.	QT 132. Vent Valve Spring.
QT 28. Triple Strainer.	QT 133. Leather Gasket.
QT 32. Drainage Plug.	QT 134. Rubber Gasket.
QT 38. Exhaust Valve.	QT 135. Cap Bolt.
QT 45. Packing Ring in Piston QT 129.	QT 136. Emergency Cap Bolt.
QT 48. Graduating Valve.	QT 137. Quick Action Piston.
QT 49. Graduating Spring.	QT 138. Quick Action Valve.
QT 71. Vent Valve.	QT 140. Quick Action Valve Spring.
QT 117. Non-Return Check.	QT 141. Quick Action Valve Cap Nut.
QT 128. Triple Piston, having an extension which forms a cylinder in which Vent Valve Piston QT 129 operates.	QT 142. Stop for Piston QT 129.

Ports and Passages. Small port F drilled through piston stem QT 129 is to supply air from the brake pipe to chamber G,

between pistons QT 128 and QT 129; passage K in the body of the triple valve is for the purpose of allowing air from the auxiliary reservoir to pass to the emergency valve QT 138; L, L is a passage in the body of the triple valve between valves QT 138 and QT 117, and is for the purpose of venting air from the auxiliary reservoir to the brake cylinder when the emergency brakes are used; QT 125 is the lower portion of the triple valve body, known as the drainage and where the pipe connection is made at triple valve W; H is a passage leading from vent valve QT 71 to quick action piston QT 137 and to the atmosphere at J. The feed groove in the triple valve body cylinder is at B.

Course of Air. Plate 131 shows the course of the air (indicated by arrows) from the time it enters the triple valve until it enters the auxiliary reservoir. Air enters the strainer at W, passes through passage A into chamber E, past piston QT 128, through feed groove B and thence to the auxiliary reservoir at C, until the brake pipe and auxiliary reservoir pressures are equalized.

Operative Parts. Plate 132 shows the following principal operative parts of the New York quick action triple valve in service application; QT 128, Main Triple Piston; QT 38, Exhaust Slide Valve; QT 48, Graduating Slide Valve; QT 129, Vent Piston.

Main piston QT 128 has the same movement for service and emergency applications and is extended to form a cylinder in which vent piston QT 129 is fitted. A small port and passage F is drilled through the stem of piston QT 129, which allows brake pipe air to pass into chamber G, formed between the vent valve piston and the main triple piston, equalizing the pressures on both sides of the vent piston.

Service Application. When a service reduction of brake pipe air is made, reducing the pressure in chamber E, the auxiliary reservoir pressure being the greater forces piston QT 128 toward the weaker pressure, closing feed groove B. Port F is made of such size that when main piston QT 128 moves slowly

270 NEW YORK QUICK ACTION TRIPLE VALVES.

to the left in a service application, as shown on Plate 132, thereby reducing the size of chamber G, the air in chamber G will pass through port F to the brake pipe without moving piston QT 129 from its normal position. In a service application the triple

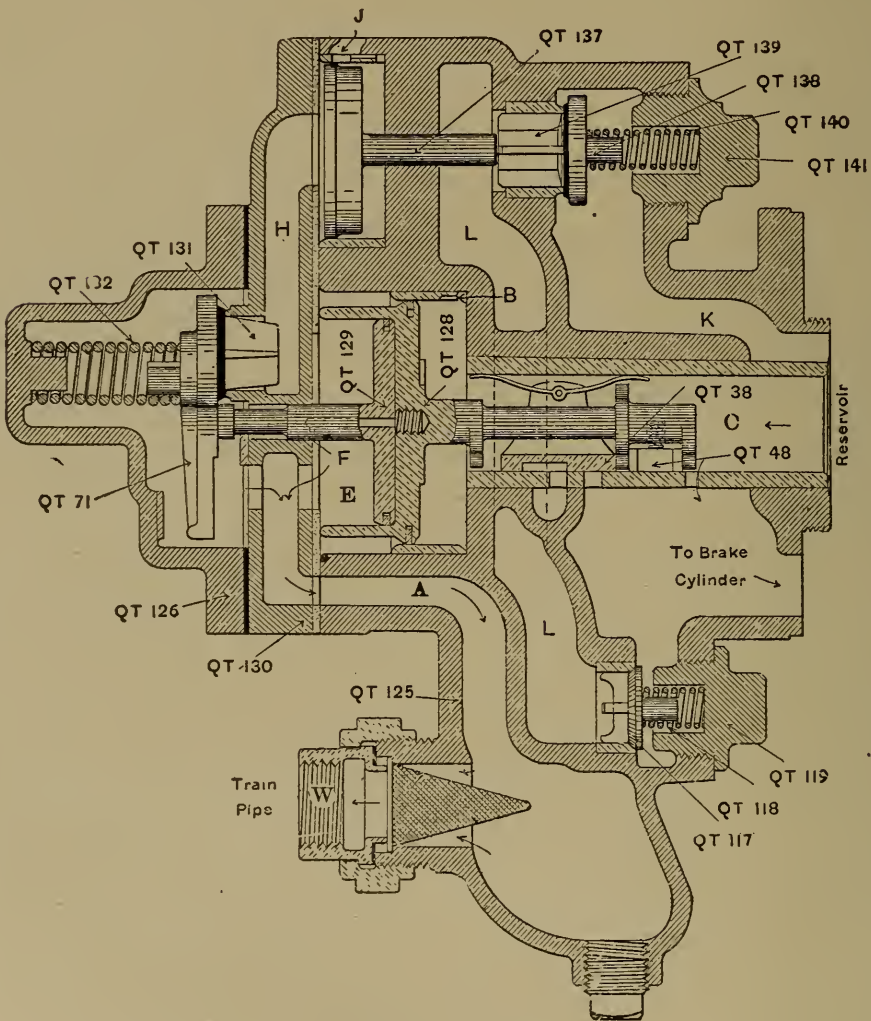


PLATE 132.

piston moves over only a portion of its stroke, bringing the small service port in the slide valve QT 48 opposite the port in its seat leading to the brake cylinder, the quantity of air admitted being in proportion to the brake pipe reduction. If the brake pipe pres-

sure is reduced but little, the pressure in the auxiliary is reduced by expansion into the brake cylinder to slightly less than that in the brake pipe. When piston QT 128 starts back and carries graduating valve QT 48 to lap position, as shown on Plate 133,

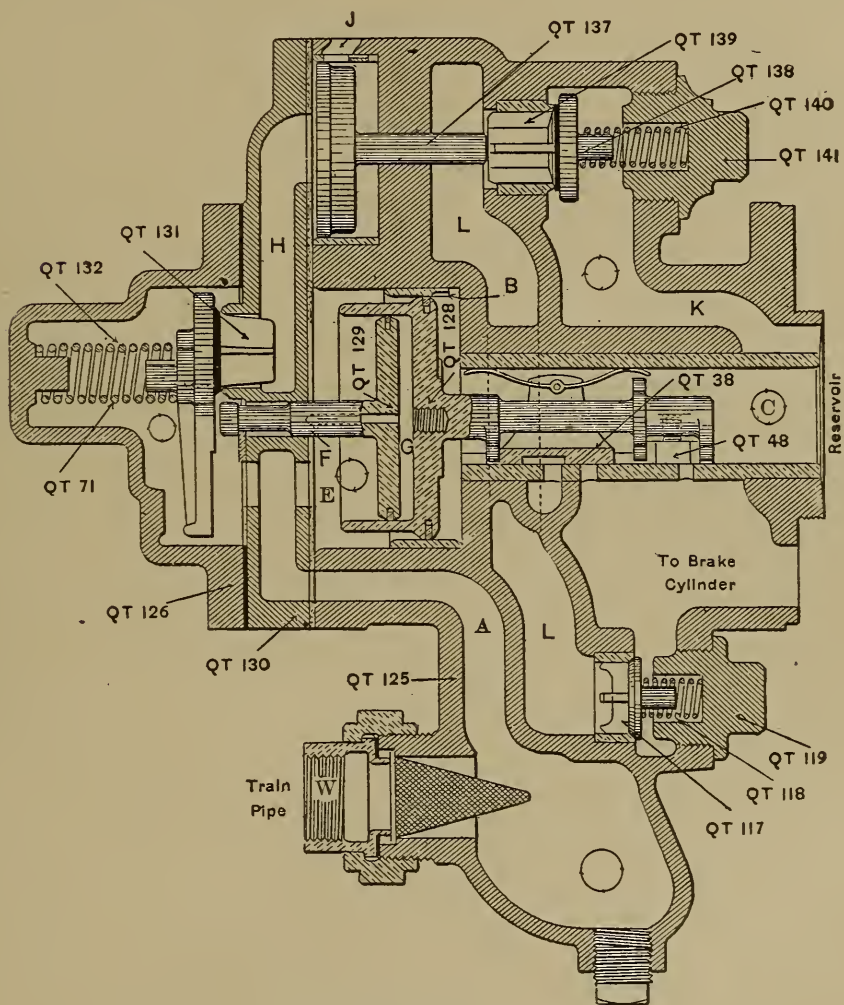


PLATE 133.

it closes the service port without disturbing exhaust valve QT 38, thus closing communication between the auxiliary reservoir and the brake cylinder.

The plain triple valve has the triple piston, the exhaust valve and the graduating valve. The additional valves described in the

list of parts are for use in emergency applications for the purpose of allowing the triple valve to vent the brake pipe air to the atmosphere and at the same time cause quick equalization of the auxiliary reservoir and brake cylinder pressures.

The additional parts of the quick action triple valve brought into use when an emergency application is made are, Vent Valve Piston QT 129, Vent Valve QT 131, Quick Action Piston QT 137 and Quick Action Valve QT 138.

In service applications these parts remain inoperative, but in an emergency application they are carried into action. Vent valve QT 131 is held to its seat by spring QT 132, assisted by brake pipe pressure, and is opened by piston QT 129. When the piston is forced to the left, quick action valve QT 138 is held to its seat by spring QT 140, assisted by auxiliary reservoir pressure, and it can only be opened when quick action piston QT 137 moves to the right.

Emergency Application. In an emergency application a quick reduction is made in the brake pipe pressure, and main piston QT 128 moves quickly to the left. The air from chamber G cannot flow through port F fast enough to reduce the pressure at the same rate as it is being reduced in the brake pipe, and a momentary excess pressure takes place in chamber G, sufficient to force piston QT 129 to the left, which in turn forces vent valve QT 131 from its seat. The vent valve being off its seat, brake pipe air enters passage H and escapes to the atmosphere through port J, but before the air escapes through port J it exerts a strong pressure upon quick action piston QT 137, forcing it to the right and causing it to unseat quick action valve QT 138. This allows the auxiliary reservoir air to flow rapidly through the large passage K, past the non-return check valve QT 117 and to flow through passage L, to the brake cylinder, shown on Plate 134.

Releasing. The brakes are released by restoring the brake pipe pressure until it exceeds that in the auxiliary reservoir, causing main piston QT 128, exhaust valve QT 38, and graduating valve QT 48 to return to their normal positions (Plate 131),

closing the service port, allowing the auxiliary reservoir to charge through feed groove B, and at the same time allowing the air in the brake cylinder to escape to the atmosphere through the exhaust cavity of exhaust valve QT 38 and the exhaust port in its seat.

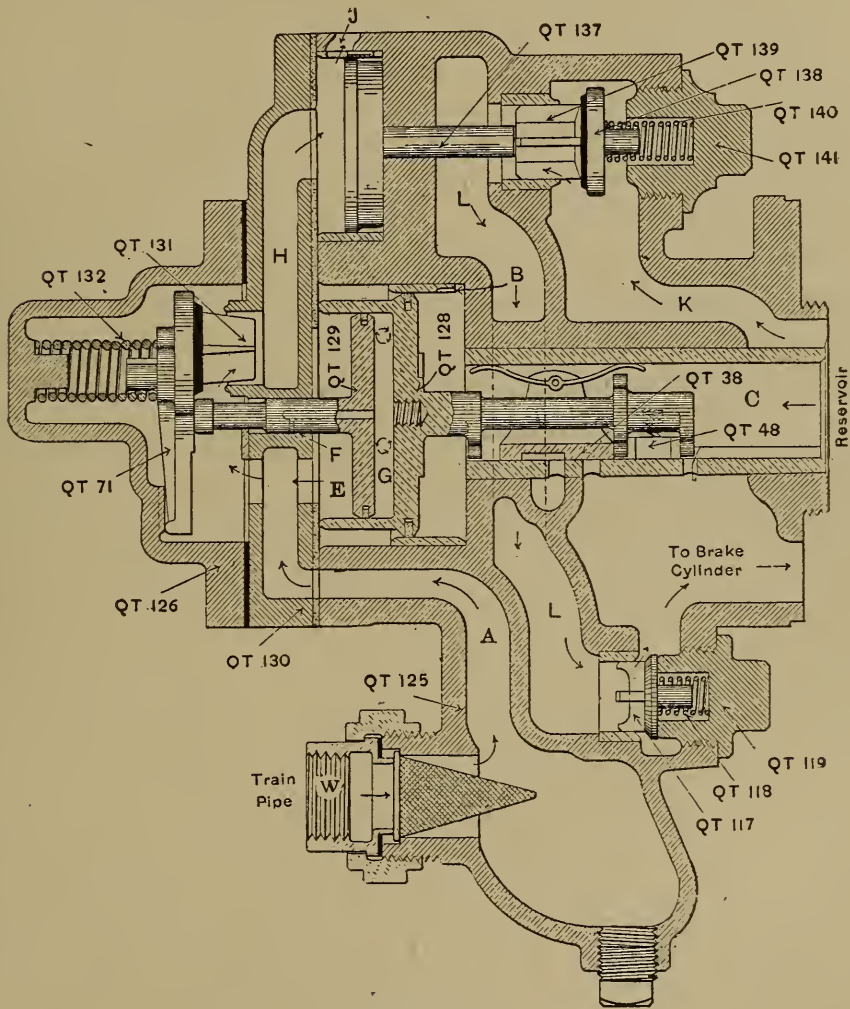


PLATE 134,

Brake Cylinder Pressure. In a service application the quick action triple valve allows the auxiliary reservoir pressure to pass to the brake cylinder gradually, as required to produce the necessary braking force, while in an emergency application it allows the

full auxiliary reservoir pressure to pass almost instantly into the brake cylinder, applying the brakes with full force, and at the same time it vents sufficient brake pipe air to the atmosphere to produce a quick reduction in brake pipe pressure, which causes the following quick action triple valve to operate in quick action, and so on throughout the train, producing a quick serial action of all the brakes.

No greater pressure is produced in the brake cylinder in an emergency than in a service application, as the triple valve uses auxiliary reservoir air in both applications.

Partial Service Application. After a partial service application, an emergency application can be made, but the quick action parts will not operate in a manner so as to produce a quick operation of all the brakes and an instantaneous equalization of pressure in the brake cylinder. However, if an emergency arises after a service application has been made, and the brake valve is placed in emergency position, allowing the brake pipe pressure to escape freely to the atmosphere, all the brakes on the train will apply with their full braking power much more quickly than if a service reduction were made. The operation of the quick action triple can be obtained only when the pistons are separated with chamber G at its normal size.

Auxiliary Pressure. As auxiliary reservoir pressure alone goes to the brake cylinder in both service and emergency applications, it might be considered that both applications will be equally effective. This is not the case, however, for the service application is slower than the emergency, and for this reason a full emergency application is much more effective than a full service application. When a partial reduction is made, followed by an emergency reduction, the comparative effectiveness depends on how heavy the service application is before the emergency application is made, and also upon the length of the train. However, when a service application is begun, and is then followed by an emergency application, the effectiveness of the brakes will not be as great as if an emergency reduction had been made at first.

Cars Cut Out. Two or three cars with brakes cut out placed together in a train will not prevent the quick action triple valves on the following cars from operating quick action. The number of cut-out triple valves that can be placed together in a train without interference of this kind depends largely on their location in the train, varying from three, placed together behind the first quick action triple valve, to six or eight, placed close to the rear of a 50-car train.

Vent Valve. Vent valve QT 131 will not remain open and exhaust all the brake pipe air to the atmosphere when an emergency application is made. Port F is always open, and the moment chamber G excess pressure is exerted on piston QT 129 it quickly equalizes with brake pipe pressure, and spring QT 132, together with brake pipe pressure, will return valve QT 131 to its seat, thus stopping the escape of air when the brake pipe pressure is reduced sufficiently to apply the brakes with full force. As valve QT 131 closes, piston QT 129 returns to its normal position, its travel in that direction being limited by stop QT 142. Valve QT 138 and piston QT 137 will return to their normal positions after equalization has taken place in the brake cylinder.

PASSENGER QUICK ACTION STYLE "S" TRIPLE VALVE.

List of Parts. The names of the parts of this new style of valve as shown on Plates 135 and 136 are as follows:

QT 9.	Exhaust Valve Spring.	QT 132.	Vent Valve Spring.
QT 20.	Rubber Seat on Valve QT 71.	QT 133.	Leather Gasket.
QT 28.	Strainer.	QT 134.	Rubber Gasket.
QT 32.	Drainage Cap Plug.	QT 135.	Cap Bolt.
QT 45.	Packing Ring on Piston QT 164S.	QT 137.	Quick Action Piston.
QT 49.	Graduating Valve Spring.	QT 138.	Quick Action Valve.
QT 71.	Vent Valve.	QT 140.	Quick Action Valve Spring.
QT 117.	Non-Return Check.	QT 141.	Quick Action Valve Cap.
QT 118.	Non - Return Check Valve Spring.	QT 142.	Stop for Piston QT 166S.
QT 119.	Non - Return Check Cap.	QT 162S	Exhaust Valve.
QT 126.	Triple Head or Cap.	QT 163.	Graduating Valve.
QT 130.	Middle Section of Flange and Seat for Vent Valve QT 131.	QT 166S	Triple Piston (including Packing Ring QT 3).

Small port F is drilled through the piston stem for the purpose of supplying air from the brake pipe to chamber G between QT 166S and QT 164S; passage K in the triple valve body is for the purpose of allowing air from the auxiliary reservoir to pass to emergency valve QT 138; L, L is a passage in the body of the triple valve between valves QT 138 and QT 117; QT 125 is the lower portion of the triple valve body known as the drainage, and provides for the brake pipe connection at W.

Graduating Valve and Ports. This style of valve used on 12, 14 and 16-inch brake cylinders is larger than the ordinary quick action triple valve; it has a large graduating port for the air to pass through to the brake cylinder; it also has a larger exhaust port and exhaust valve QT 162S, and has the graduating valve QT 163 mounted on top of exhaust valve QT 162S (Plate 135).

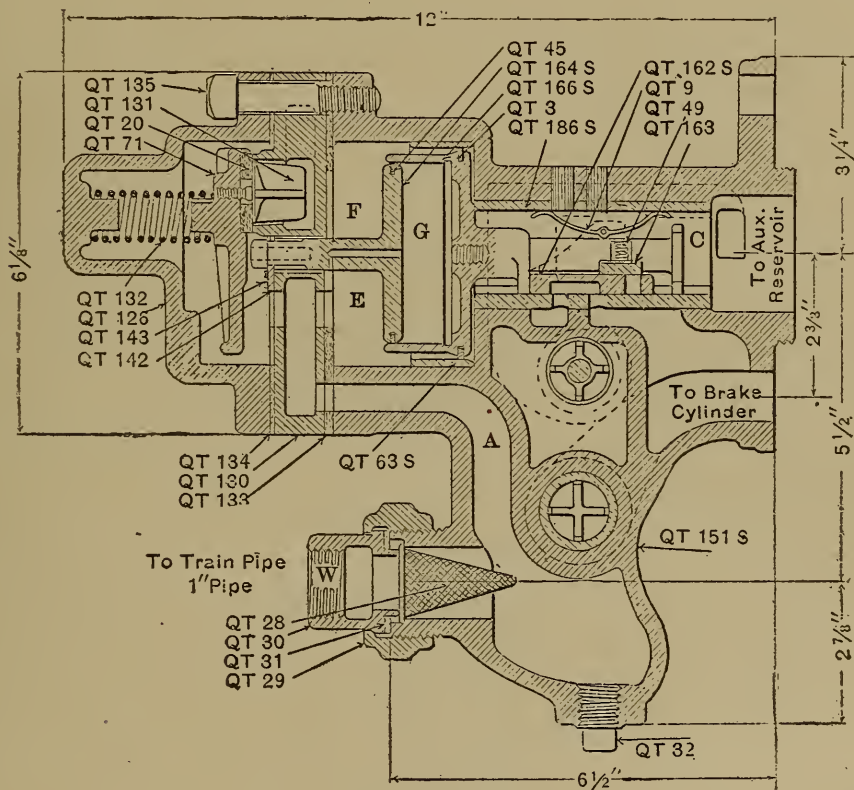


PLATE 135.

Friction. The friction of the operative parts is reduced by placing graduating valve QT 163 on top of exhaust valve QT 162S. When triple piston QT 166S begins to move, the graduating valve moves first to uncover the service ports in exhaust valve QT 162S; then the exhaust valve is moved until the graduating ports in the exhaust and its seat come in register. In this style of triple valve but one slide valve is moved at a time.

278 NEW YORK QUICK ACTION TRIPLE VALVES.

Different Types. This style of triple valve can easily be distinguished from the freight and 10-inch passenger triple valves, as the letter "S" is cast in the body of the valve and the triple valve is fastened to the brake cylinder with three studs. The letter "S" is also stamped or cast on all parts of this valve that are not interchangeable with those of the other valves mentioned.

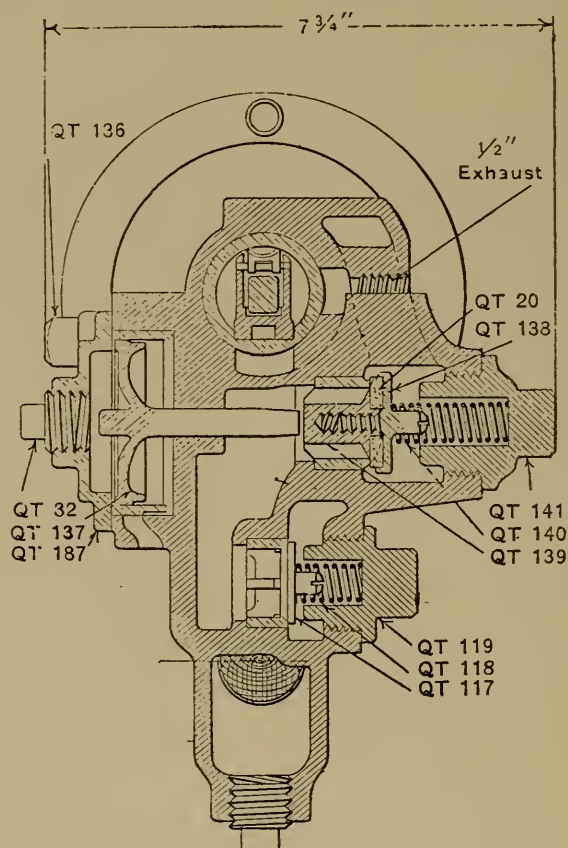


PLATE 136.

The difference between styles "S" and "P" of the triple valve and the freight triple valve is that the side cap of the "S" and "P" is tapped out for a one-half-inch pipe, and a plug inserted. This is done for the purpose of attaching a pipe from the triple valve to the compensating valve with the high speed brake.

DEFECTS OF THE NEW YORK QUICK ACTION TRIPLE VALVES.

If graduating valve QT 163 in the style "S" triple valve leaks it can be detected by making a partial service reduction, and then noting whether the brake released of its own accord. A leak of this kind will not allow the auxiliary pressure to escape through the exhaust port while exhaust valve QT-162S is in release position, for in this position it closes the opening from the auxiliary reservoir to the brake cylinder and atmosphere, and air leaking by the graduating valve QT 163 cannot escape.

Cap Nut. If cap nut QT 141 is not securely fastened or the emergency valve leaks it will allow auxiliary reservoir pressure to leak away the same as a slightly open release valve. If the amount of leakage is large it will cause the brake to release.

Leaky Check Valve. If the check valve leaks or cap nut QT 119 is not securely tightened it will allow all brake cylinder air to leak away, reducing the braking power, the same as with a leaky piston packing leather.

Blow at Port J. A constant blow of air from port J in the side of the triple valve indicates that the vent valve is leaking. If accompanied by a blow at the triple exhaust port it indicates that the quick action or emergency valve is leaking. If the vent valve leaks it will be indicated by the application of the brake when the cut-out cock in the cross-over pipe is closed; but if the emergency valve leaks the brake will not apply with the closing of the cut-out cock.

Maintaining Pressure. If it is difficult to maintain normal brake pipe pressure and the brakes will not release properly it indicates a bad leak in the brake pipe. The hose and brake pipe connections should be carefully examined and it should be noted whether there is a blow at port J of the triple valve. The leakage will be coming direct from the brake pipe, due to vent valve QT 131 not being seated properly, or the rubber seat being defective.

Brake Applying in Quick Action. If a brake applies in quick action when a service reduction is made it may be due to the

packing rings in vent piston QT 129 fitting the cylinder too tightly, a weak vent valve spring QT 132, or small port F in vent valve piston QT 129 being stopped up.

If the brakes do not apply in quick action when the proper reduction is made the packing ring of vent valve piston QT 129 may be worn or fit poorly.

Blows at the Triple Exhaust. A blow at the triple exhaust would be due to leaky exhaust valve QT 38, leaky graduating valve QT 48, a defective gasket between the body of the triple valve and the brake cylinder head with passenger equipment, a defective gasket between the auxiliary reservoir and the triple valve with freight equipment, or a leak in the auxiliary tube leading from the triple valve to the brake cylinder.

A leaky exhaust valve would cause a blow at the exhaust port, whether the brake were applied or released, and when applied it would cause the brake to release.

Leaky Graduating Valve. A leaky graduating valve, with the triple valve in lap position, will allow the auxiliary pressure to escape under the graduating valve and through the port into the brake cylinder, reducing the auxiliary pressure and setting the brake with greater force. Whether this will allow the brake to release will depend upon whether or not the piston packing ring is tight. If the packing ring is in good condition the auxiliary reservoir pressure will continue to feed by the defective graduating valve until sufficient reduction exists between the brake pipe and the auxiliary reservoir to start the exhaust valve, when it may move to release position and release the brake.

Defective Piston Packing Ring. If the piston packing ring or the piston is defective, and air leaks into the auxiliary reservoir as fast as it leaks by the graduating valve into the brake cylinder, the brake will continue to set instead of releasing, until the pressures are equal; therefore, under such conditions, a leaky graduating valve cannot release the brake.

Failure of Brakes to Apply. A failure of the brakes to apply on a car when a brake pipe reduction has been made may be due

to the feed grooves or strainer being stopped up, preventing the auxiliary reservoir from charging, or the triple valve may be sticky, gummed or dirty, so that the piston cannot move. In this case the brake will not apply on the car with the defective triple when a service reduction is made. If a heavy reduction is made the triple valve may be forced loose and it will probably work satisfactorily during the remainder of the trip.

Sticky Triple Valve. A sticky triple valve is sometimes the cause of a brake applying in quick action on a car during a service brake pipe reduction. In this case the triple valve will not usually respond to the first and sometimes the second service reduction, and the brake on the car with the defective triple valve will not apply until the difference between the auxiliary reservoir and brake pipe pressure is sufficient to cause the triple piston to start from its stuck position and move forward quickly to emergency position, the stem striking sufficiently hard to compress spring QT 132 and open vent valve QT 131, thus causing quick application of the brakes on this car.

Brakes Failing to Release. If a brake fails to release and there is a strong blow at port J it may be due to vent valve QT 131 being held from its seat by dirt or scale, or a badly worn triple piston packing ring, which would allow the brake pipe pressure to feed slowly by the packing ring, charging the auxiliary reservoir, without forcing the piston to release position, and releasing the brake.

How to Locate Defective Triple. To locate a leaky or defective triple valve, with a full brake pipe pressure, a reduction of from 5 to 10 pounds should be made, the amount depending on the length of the train. The brake piston that has failed to move out should then be looked for, and when it is found the brake on this car should be cut out and the test repeated in order to render it certain that the faulty triple valve has been located. On freight trains a sectional test should be made until the defective triple is located, as previously described.

period during which the pressure is held is automatically shortened or lengthened according to the variation obtained in the maximum brake cylinder pressure on the piston, or in both combined, as the valve makes allowance in the time of holding this pressure. On account of these variations the closure of all valves upon the train will be practically uniform.

List of Parts. The compensating valve consists of the following parts: HS 77, Piston Valve, which works in a bushing or cylinder; HS 81, Packing Rings, there being two of these, either of which may act as a valve for the relief and leakage port; HS 11, Regulating Spring, by which the piston is held in its normal position against the brake cylinder pressure; HS 12, Regulating Nut or Screw, by means of which the tension of the spring is regulated; HS 87, Non-Return Check Spring; HS 76, Spring Box; HS 10, Cap Nut; HS 83, Non-Return Check Valve with casing complete.

Emergency. In an emergency application the air vented from the brake pipe into spring box HS 76 passes non-return check valve HS 83, which then seats and prevents the air that is entrapped in the spring box from escaping, except as it passes out slowly through the small port drilled through the check valve (see piping diagram, Plate 138).

Piping. The compensating valve is connected with the brake cylinder and the triple valve as shown in the piping diagram (Plate 138). With the style "A" compensating valve a one-half-inch pipe connection is made from the chamber above piston HS 77 and the brake cylinder, and another pipe connection leads from the side cap of the quick action triple valve to spring box HS 76, which has direct communication with the air chamber below piston HS 77. All the pipe connections should be tight.

Operation. When style "A" compensating valve is piped, as shown on Plate 138, and an emergency application is made, a portion of the brake pipe air is vented at the side cap of the quick action triple valve and passes through the pipe leading to the non-return check valve and spring box chamber, charging the spring

box chamber under the piston with air pressure. This pressure reinforces the regulating spring pressure under the piston and permits the full equalization from the auxiliary reservoir to be had and retained for several seconds before piston HS 77 can descend and open the relief ports. The air vented into and entrapped in the spring box chamber requires several seconds to pass to the atmosphere through the small port in non-return check valve HS 83. When the air pressure in the spring box air chamber has been reduced sufficiently below brake cylinder pressure, the piston will be forced downward, the relief ports controlled by packing rings HS 81 will be opened and the brake cylinder pressure will be gradually reduced to the point of adjustment of the valve.

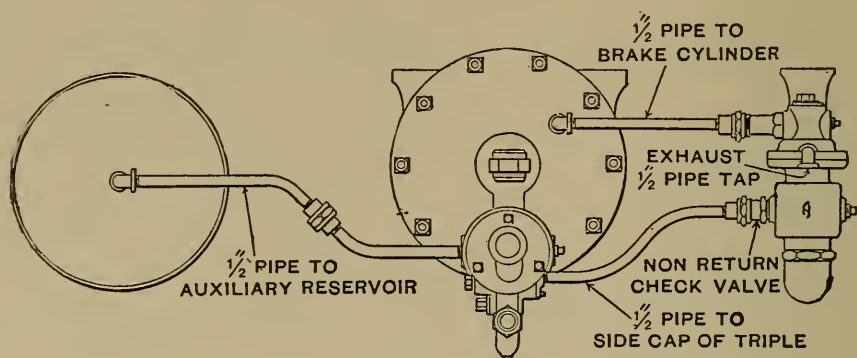


PLATE 138.

In a service application no air is vented into the spring box air chamber, and the only pressure which the piston has to overcome is that of regulating spring HS 11. Consequently when the pressure in the brake cylinder is sufficient to overcome the tension of the regulating spring the piston will be forced downward, promptly opening the relief ports.

Attaching Spring Box. Care should be exercised when bolting the spring box to the body of the valve to see that gasket HS 90 is in good condition and that the bolts are drawn up tightly in order to form a perfectly air tight joint between the valve body and the spring box, so that the air entrapped in the spring box chamber by the non-return check valve HS 83 will have no

other means of escape than through the small port in the check valve, thus regulating the escape of the air.

Packing Rings. The purpose of piston packing ring HS 81 is to form an air tight joint in the cylinder, preventing brake cylinder pressure from leaking past the piston into the spring box chamber, and it also closes the relief port when in normal position.

The lower ports controlled by the lower packing rings are leakage ports and their function is to carry to the atmosphere whatever pressure may leak by upper packing ring HS 81, thus preventing any leakage into the spring box chamber that would tend to balance the piston and retard the escape of air from the brake cylinder.

When piston HS 77 is in normal position, lower packing ring HS 81 covers the leakage ports and prevents the spring box air from leaking by this ring to the atmosphere in emergency application. When piston HS 77 has moved to the lower end of its stroke, and the leakage ports to the upper and lower packing rings are about midway between the two rings, it is evident that any leakage by the upper packing ring will pass out through these ports.

Advantages of High Pressure. The advantage of holding the maximum cylinder pressure obtained from a pressure of 110 pounds is that an emergency application is more effective in retarding the motion of the train at high speeds. If the maximum cylinder pressure is retained until the speed of the train has been reduced, the reducing valve will vent all surplus air above that pressure for which the adjusting spring is set, thus preventing the wheels from sliding at slow speeds.

Also in service application two or more powerful applications can be made without recharging the auxiliary reservoirs, and there will still remain sufficient pressure to make an ordinary emergency application, such as would be had from a 70-pound brake pipe pressure.

Use of Compensating Valve on Different Sizes of Cylinders. The compensating valve can be used on any size of cylinder,—6, 8, 10, 12, 14 and 16-inch. The rate of reduction in brake cylinder pressure will be about the same with the 16-inch cylinder as with the 10-inch when the compensating valve is used.

When the compensating valve is used on 10-inch and 12-inch brake cylinders, union stud HS 14A is used. The opening through this stud is reduced or, in other words, there is a choke placed in it, which to a large degree regulates the flow of air from the brake cylinder to the compensating valve and through the latter to the atmosphere. One size of this union stud goes with the 6 and 8-inch, another with the 10 and 12-inch and another with the 14 and 16-inch brake cylinders. Therefore it will be seen that a size of choke can be used with each size of brake cylinder that will give exactly the same rate of reduction. The stud is the part that must be used with the corresponding size of brake cylinder, as but one style of compensating valve is used on the different sizes of cylinders.

Adjustment. The compensating valve is usually adjusted to withstand a pressure of 60 pounds, although for driver brakes, tender brakes and such cars as are provided with a standard foundation brake gear the adjustment is sometimes varied from this.

NEW YORK TRAIN AIR SIGNAL SYSTEM.

SIGNAL REDUCING VALVE.

Plate 139 is a cross sectional view of the signal reducing valve. X is the main drum connection and Y is the connection to the signal line.

List of Operative Parts. The operative parts are as follows:

SR 24. Supply Valve.	SA 32. Diaphragm.
SR 26. Supply Valve Spring.	SA 34. Regulating Nut.
SR 27. Supply Valve Seat.	SR 41. Cut-Out Plug.
SR 28. Piston Packing Ring.	SR 42. Choke.
SR 29. Piston.	PG 141. Regulating Spring.
SA 31. Diaphragm Ring.	

Operation of the Reducing Valve. The main drum pres-

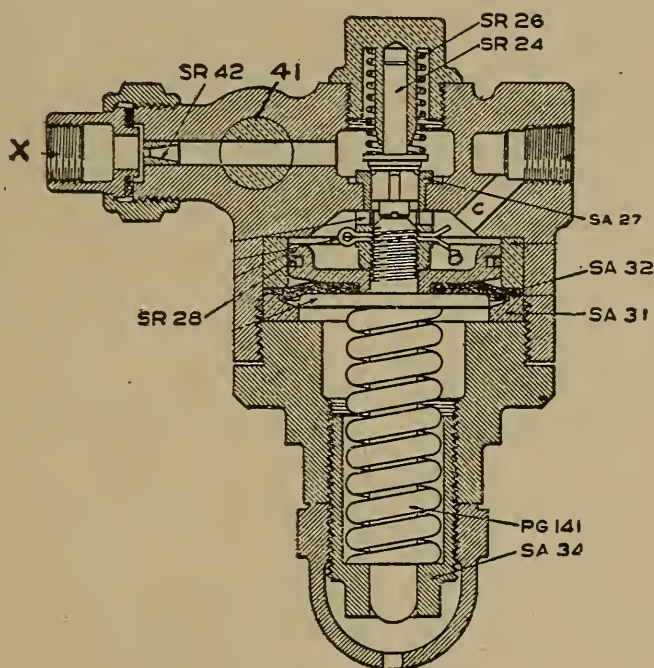


PLATE 139.

sure enters at X, and regulating spring PG 141, acting on diaphragm plate SA 32, causes the stem of the plate to hold supply valve SR 24 from its seat, so that the main reservoir pressure is free to pass through the supply valve to chamber B on top of the diaphragm and through passage C to the signal line at y,

increasing the pressure in the signal line and chamber B until it reaches 40 pounds. When piston SR 29 is forced downward against the tension of regulating spring PG 141, supply valve SR 24 is forced to its seat by main drum pressure and supply valve spring SR 26. When a reduction is made in the signal line the top of diaphragm SA 32 is affected. Regulating spring PG 141, forcing up on the diaphragm, unseats supply valve SR 24, compressing supply valve spring SR 36; the main drum pressure is then free to flow by the supply valve to the signal line, charging the latter in the manner described.

SIGNAL VALVE.

The signal valve, as shown on Plate 140, is generally located under the footboard of the cab. The signal pipe is connected to it at X, while a pipe leads from Y to the signal whistle. The valve body is divided into two chambers, A and B, by a rubber diaphragm SV 3, which operates diaphragm stem SV 4A. This rubber diaphragm has two disks, the lower one SV 6 of brass and the upper one SV 12 of sheet iron, and through these disks is screwed a brass plug, through which a hole is drilled for the passage of air. Valve SV 8 is held to its seat by gravity and controls the passages leading to the whistle. There are three uprights AA that press against the disk or valve and lift it from its seat whenever diaphragm SV 3 rises. The clearance between the uprights and the disk of stem SV 8 should not exceed 1/100th of an inch.

Operation. When the signal pipe is being charged, air enters the signal valve at X and, passing through small port J, charges chamber A. It also passes through passage CC and feeds down slowly to chamber B, charging it to the same pressure as chamber A. The pressures in chambers A and B and the signal pipe are equal when the signal line is fully charged. When the signal cord is pulled and a reduction is made in the signal line pressure it also causes a reduction of pressure in chamber A of the signal valve, but passage CC being very small the pressure in chamber A above diaphragm SV 3 reduces faster than the pressure in chamber B; consequently the diaphragm and uprights AA are

forced upward and raise exhaust valve SV 8 from its seat, thus permitting the air in chamber A to flow into passage E leading to the whistle, which causes a blast. The same reduction of pressure that operates the signal valve also opens the reducing valve, which then allows the pressure from the main reservoir to pass through the reducing valve and into the signal line, raising the pressure to normal. This increase of pressure, following immediately after the reduction in the signal line, increases the

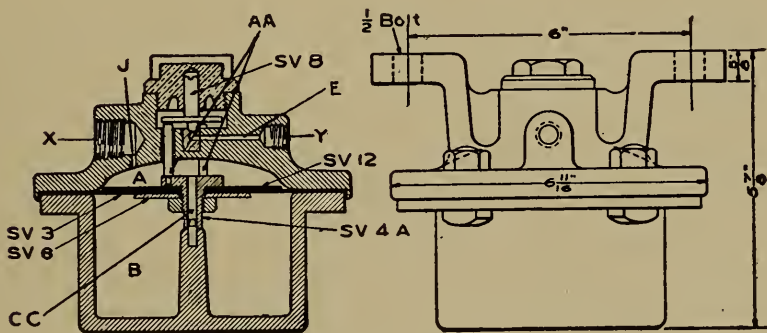


PLATE 140.

pressure in chamber A faster than in chamber B, thus forcing the diaphragm downward and permitting exhaust valve SV 8 to close passage E, thus stopping the flow of air to the whistle.

All other parts of the New York air signal equipment not mentioned herein are interchangeable with and operate upon the same principle as those of the Westinghouse Air Signal equipment, previously described on pages 97 to 103.

DEFECTS OF THE NEW YORK AIR SIGNAL SYSTEM.

Although there are comparatively few parts in the air signal system it requires good judgment to locate defects that will cause improper operation.

If the signal system fails to charge it should first be noted that the cocks between the first car and the tender are open; if open, the lining of the hose may be loose, blocking the passage, and if in cold weather the signal line on the engine and tender may be frozen up or not cut in, or the regulating spring of the reducing valve may be broken.

If the signal line charges but fails to respond when a reduction is made, it may be due to the clogging up of the strainer in the tee pipe connection of the branch pipe with the signal pipe. If this is the case the exhaust may sound all right, as there will be considerable air in the branch pipe between the strainer and the discharge, but the air in the main pipe will be unable to get past the strainer fast enough to make the reduction sufficiently quick to operate the signal valve; or it may be that the small port of the signal valve is stopped up, preventing the air from entering the chamber above the diaphragm and charging the valve; or the small port in the stem of the diaphragm may be stopped up, which will allow the chamber below the diaphragm to charge, but when a reduction is made in the signal line there would be no pressure under the diaphragm to raise it, and no blast of the whistle would result.

A failure of the whistle to sound may be due to improper adjustment of the bell of the whistle, the bowl becoming filled with dirt or by the whistle being placed in such a position that a draft from an open window may prevent it from sounding.

If the whistle gives one long blast it may be due to the reductions being made too close together or by the disk becoming loose from its seat.

If the whistle blows when the brakes are released it indicates that there is a direct communication between the main reservoir and the signal line, allowing the latter to become charged to main reservoir pressure. In releasing the brakes the pressure in the main reservoir is reduced, and if the opening is large enough and the main reservoir pressure is reduced sufficiently fast, air will flow from the signal line to the main reservoir, and the reduction in the signal line will allow the signal valve to operate, causing the whistle to give a blast. This may be caused by the regulating spring of the reducing valve being too great, a leak by the diaphragm with the vent port in the spring box stopped up, or the supply valve of the reducing valve being held from its seat by dirt or other foreign matter.

SUMMARY OF AIR BRAKE OPERATION AND TRAIN HANDLING.

DEFINITION OF THE AIR BRAKE.

An air brake is a power brake operated by compressed air.

TRACING AIR THROUGH THE BRAKE SYSTEM.

The course of the air through the brake system is as follows: Air enters the strainer of the 9½-inch, 11-inch and cross-compound pumps, and at the air inlets of the 8-inch pump, passes the receiving valve to the air chamber of the pump, is compressed by the air piston, passes the discharge valves to the discharge pipe, thence to the main reservoir, from the main reservoir through a return pipe to the engineer's brake valve, passes into the engineer's brake valve when it is in full release or running position, and through suitable ports to chamber D, from chamber D to the black hand of the air gauge; also to the brake pipe and the pump governor of the D-8 brake valve, through the cut-out cock below the brake valve, through the hose and couplings to the first closed angle cock in the train, and to the conductor's valve of each coach and way car, through the cross-over pipe and cut-out cock to the triple valve, and through the feed grooves of the triple valve, when in release position, to the auxiliary reservoir, charging the latter. When a sufficient reduction is made at the brake valve, or from the train line, it will cause the auxiliary reservoir pressure to force the triple valve to set position, allowing auxiliary pressure to feed to the brake cylinder, thus applying the brake. Restoring the brake pipe pressure above that in the auxiliary reservoir, or reducing the auxiliary pressure below that in the brake pipe, will cause the triple valve to move to release position, allowing the air in the brake cylinder to pass to the atmosphere through the triple exhaust and retainer. Air from the main reservoir passes to the pump governor of the G-6 and ET brake valves, to the red hand of the air gauge, to the face of

all valves on the engine operated by main reservoir pressure, and to the main reservoir side of the signal reducing valve. If the engine is equipped with straight air brakes it passes to the main reservoir side of the straight air reducing valve.

BRAKE PIPE PRESSURE.

A brake pipe pressure of 70 pounds should be carried with the ordinary brake, 90 pounds with schedule "U" equipment and 110 pounds with the high speed brake.

The brake pipe pressure is regulated through the brake valve by means of the pump governor with the D-8 brake valve, through the feed valve attachment with the G-6 and ET equipments and with the pressure control or pump governor with the New York brake equipment.

EXCESS PRESSURE.

Excess pressure is the amount of pressure carried in the main reservoir over and above that in the brake pipe. It should be carried at all times, except when charging a train at terminals or recharging while descending heavy grades, and it should be carried then if practicable.

The amount of excess pressure that should be carried with the different styles of brake valves is as follows: With the D-8 brake valve, 15 pounds for short passenger trains and 20 pounds for freight or long passenger trains; with the G-6 brake valve, single governor, 20 pounds for passenger or short trains and 30 pounds for long freight trains; with the double governor, 20 pounds for passenger and short trains, with brake valve in either running or lap position, and for long freight trains, 20 pounds in running position and 50 pounds in lap position; with the schedule "U" or ET valve, 10 to 20 pounds in both running and lap positions, and the same with the New York brake.

Purposes of Excess Pressures. Excess pressure is carried to insure a prompt and certain release of all brakes, especially with long trains, to insure a quick recharge of the brake pipe and auxiliary reservoirs, and to operate the different appliances on the locomotive that are operated by main reservoir pressure without interfering with the brake pipe pressure.

A greater excess pressure is carried on freight than on passenger trains, for the reason that on freight or long trains there is a greater volume of air to control, a larger number of auxiliary reservoirs to recharge and it is more difficult to release the brakes than on a short train.

STORAGE OF PRESSURES.

The compressed air used on an engine and train is stored in the main reservoir, small drum, brake pipe, auxiliary reservoirs and signal line.

Main reservoir pressure is stored in the main reservoir and its pipe connections, and is used to operate the different devices on the engine and for charging and recharging the brake pipe, auxiliary reservoirs and signal line.

Chamber D pressure is stored in chamber D and the small drum. Its purposes are to allow the engineman to do gradual braking, hold the equalizing piston to its seat and operate the black hand of the air gauge.

Brake pipe pressure is stored in the brake pipe, and is used to operate the pump governor of the D-8 brake valve, charge and recharge the auxiliary reservoirs, apply and release the brakes, and assist in applying the brakes in emergency applications with the old type quick action triple, and in service and emergency applications with the "K" triple valve.

Auxiliary pressure is stored in the auxiliary reservoir; its duty is to hold the slide valve to its seat, operate the quick action parts of the triple, set the brake and also to charge the water pressure on tourist cars that are so equipped.

Signal line pressure is stored in the signal line and in chambers A and B of the signal valve. It is used to transmit signals from trainmen to enginemen.

BEGINNING AND ENDING OF PRESSURES.

Main reservoir pressure begins on top of both discharge valves; it ends at the top of the rotary valve in the engineer's

brake valve, and at the faces of all valves operated by main reservoir pressure.

In running position with the D-8 brake valve it ends at the main reservoir side of the excess pressure valve, at the main reservoir side of the feed valve with the G-6 brake valve, at the low pressure pump governor of the duplex on freight, if attached to the running feed port, and at the red hand of the air gauge and the high pressure governor.

Straight air pressure begins at the straight air side of the reducing valve and ends underneath the application valve of the straight air brake valve.

Signal line pressure begins at the signal line side of the signal reducing valve and ends at the first turned cut-off cock in the train, at the car discharge valves of the coaches and in chambers A and B of the signal valve.

Chamber D pressure begins at the equalizing port and ends at the top of the equalizing piston, in the small drum and at the black hand of the air gauge.

Brake pipe pressure begins in cavity C of the rotary valve and in the brake pipe side of the feed and excess pressure valves, and ends at the pump governor of the D-8 brake valve, underneath the brake pipe side of the equalizing piston, the first closed angle cock in the train, the conductor's valve of the coach or way car, the plain side of the triple piston and in chamber Y.

Auxiliary pressure begins at the auxiliary side of the triple piston and ends in the auxiliary reservoir, the water pressure governor of Pullman and tourist cars, and the face of the slide valve.

GENERAL INFORMATION RELATING TO AIR BRAKE PRACTICE.

Time Consumed in Charging. With a constant pressure of 70 pounds in the brake pipe, the auxiliary reservoirs of short trains should charge in about 70 seconds but, owing to clogged strainers, feed grooves, the difference in the size of feed grooves and the capacity of auxiliary reservoirs, it ordinarily takes from

2 to 2½ minutes, and on long trains from 5 to 10 minutes. An engineman should bear this in mind before releasing to make a second application, while charging the train at a terminal and before releasing to recharge while descending heavy grades.

Air Gauge Indications. The black hand of the air gauge indicates the brake pipe pressure when the brake valve is in full release, running and lap positions, when chamber D and brake pipe pressures have equalized, and also at the beginning and ending of a brake pipe exhaust in a service application, but not during the brake pipe exhaust or in an emergency application.

Equalization of Pressures. Brake pipe and auxiliary reservoir pressures are equal when both are charged and in lap position of the brake valve, but they are not the same when charging, applying or releasing the brakes, in an over-reduction or in an emergency application.

Sources of Air to Brake Cylinders With Different Types of Triple Valves. The air that enters the brake cylinder passes from the auxiliary reservoir in service and emergency applications with the plain and quick action triple valves, from both the brake pipe and the auxiliary reservoir in an emergency application with the quick action triple, and from the brake pipe and auxiliary reservoirs in service and emergency applications with the "K" type triple valve.

Piston Travel. The proper piston travel is from 6 to 9 inches on cars, tenders and engine trucks; 2 to 4 inches on cam driver brakes, and 4 to 6 inches with American driver brakes.

Slack Adjustment. Slack in the brake rigging is taken up on passenger cars by means of turnbuckles, dead levers, or the patent slack adjuster; on freight cars and tenders by dead levers, or bottom rods for inside connected brakes; on cam driver brakes by lengthening the arms; on truck brakes by lengthening the outside arm, and on the American driver brake by adjusting the screw bolt or turnbuckle. The shoes of the cam driver brakes are prevented from rubbing against the tires by means of the adjusting rods or springs.

Braking Power. The braking power is dependent largely on the piston travel; the shorter the piston travel, the greater the braking power, and the higher the pressure at which the auxiliary reservoir and brake cylinder pressures will equalize; the longer the piston travel, the lower the pressure at which they will equalize, and the weaker the braking power.

With the same piston travel the holding power of the brakes will be alike on empty and loaded cars, but the empty car will be brought to a stop in less distance than the loaded car, this being due to the fact that the brakes must overcome the greater weight, in addition to the momentum of the loaded car.

Driver and Tender Brakes. Poor driver and tender brakes have a tendency to increase the number of flat wheels on cars, as the cars must necessarily stop the engine, instead of the engine helping to stop the cars; this causes the train brakes to be used more severely.

It is of the utmost importance that the driver brakes be kept in good condition, as they are the most powerful brakes on the train and the most expensive. They also keep the tires worn down evenly, prevent the engine from pulling away from the tank, prevent break-in-twos near the head end of the train and keep the slack in the train well bunched.

Wheels Sliding. Wheels generally slide at low and not at high speeds, as the friction between a wheel and brake shoe increases as the speed of the wheel decreases.

During cold weather an engineman should always examine the tank wheels before starting out, to see that no brake shoes are frozen to the wheels, which can be detected by moving the engine and watching the wheels to see that they revolve.

The wheels on a passenger car are more liable to slide than those on a freight car, as a passenger car has a braking power with an emergency application of 90 per cent of the light weight, while the braking power of empty freight cars is only 70 per cent of the light weight.

Reductions and Applications. Many persons do not distinguish the difference between a reduction and an application. An application consists of any number of reductions without releasing the brakes, and may be made several times during an application.

Leakage Grooves. The purpose of the leakage grooves in the brake cylinder is to provide for leakages or slight reductions in brake pipe pressure which would cause the triple valve to move to service position, closing the triple exhaust. Any small volume of air that passes from the auxiliary reservoir to the brake cylinder can pass through the leakage grooves without forcing the piston out, and applying the brakes. These leakage grooves are from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches long and are usually placed on the side or top of the brake cylinder, on the pressure end, or where the piston lies when the brake is released.

Forcing Pistons Past Leakage Grooves. In making a service application the first reduction should be sufficient to force the pistons past the leakage grooves; from 5 to 10 pounds will be required, according to the length of the train. A slight reduction is sufficient for a short train, but a heavier one is necessary for a long train.

Amount of Reduction. When making a service reduction with any given pressure the proportion it should be reduced to secure a full application of the brakes would, with a standard piston travel of 8 inches, be about two-sevenths of the brake pipe pressure, as the auxiliary reservoir is usually about $2\frac{1}{2}$ times larger than the brake cylinder.

A 10-pound reduction from a brake pipe pressure of 65 pounds will not apply the brake with greater force than a 10-pound reduction from a 50-pound brake pipe pressure, as there is a pressure of only 10 pounds going to the brake cylinder, and it is above the equalization point for the two pressures.

If a reduction of two-sevenths of the brake pipe pressure is made with an 8-inch piston travel and a 70-pound brake pipe pressure, the auxiliary reservoir, brake cylinder and brake pipe pressure will equalize at five-sevenths, or 50 pounds.

With a pressure of 35 pounds in the brake pipe and auxiliary reservoirs it would be necessary to make a reduction of two-sevenths, or 10 pounds, with an 8-inch piston travel, in order to obtain full braking power of this pressure.

A greater pressure can be obtained in the brake cylinder by carrying a higher brake pipe pressure, shortening the piston travel, or making an emergency application with the quick action triple valve, and by the use of the retaining valves in a second application with both service and emergency applications.

Over-Reduction. An over-reduction is one in which the brake pipe pressure is reduced below the point at which the auxiliary reservoir and brake cylinders equalize. It results in a useless waste of brake pipe air and an irregular and often a difficult release of the brakes. Also, if there is a defective packing ring and gasket in the triple valve on which the triple piston is seated, air can feed from the auxiliary reservoir to the brake pipe, and decrease the braking power of the car having the defective packing ring.

Service Applications. One application of the brakes is all that is necessary to stop any train, but it is advisable on passenger trains to make two applications in order to insure smooth and accurate stops, without danger of wheel sliding. More than one application is not advisable on freight trains on account of the uneven piston travel. On a long freight train with the old style triple valve, the head brakes will release before the rear brakes, allowing the slack to run out, with consequent danger of breaking in two. More than two applications should not be made in any case, as sufficient time would not be given between applications for the auxiliary reservoirs to recharge, thus decreasing the braking power.

Emergency Applications. An emergency application should be made only in cases of actual emergency to prevent an accident. In making an emergency application the handle of the brake valve should be placed in full emergency position as quickly as possible and left there, and a flow of sand started at once. It is

possible to get emergency action of the brakes without losing all brake pipe air, but it is not good practice to attempt to save air at times of pressing danger, and is not advocated under any circumstances. If it is practiced when several cars which are cut out are placed together, only the brakes ahead of these cars will go into emergency application, while those behind them will apply with only partial service action. If the brake valve is left in full emergency position a full service application will be had on all cars back of the cut-out cars, obstructed hose, or partly closed angle cock, in addition to full emergency application on all cars ahead of them. The greatest possibility of danger is that an engineman may thoughtlessly bring the brake valve past lap position too far, placing it in running position and thus releasing the brakes. Also if the brake valve were moved to lap position too quickly the sudden stoppage of air in the head end of the brake pipe would release the head brakes, which might also result in parting the train.

Releasing. To release the brakes it is necessary to raise the brake pipe pressure the entire length of the train above the pressure in the auxiliary, this generally being sufficient to overcome the frictional resistance of the triple piston and slide valve. If, however, an over-reduction has been made it will be necessary to increase the brake pipe pressure the amount of the over-reduction, plus the amount required to overcome the resistance of the triple piston and slide valve.

When it is desired to release the brakes the brake valve handle should be moved to full release position regardless of the length of the train. When all the brakes are released, and before they are overcharged, the brake valve handle should be returned to running position. The length of time required for releasing depends entirely on the length of the train, the amount of the reduction and the size of the main reservoir. Ordinarily one-half second for each car is sufficient for the release of all brakes.

An engineman should learn to release the brakes by watching the air gauge. When the brake valve handle is placed in release

position the main reservoir and brake pipe pressures should practically equalize, but not overcharge. On short trains this equalization takes place very rapidly; consequently the brake valve handle should be returned to running position before overcharging takes place. On long trains equalization takes place slowly, the rear end of the train receiving its increase of pressure more gradually, due partly to frictional resistance in the brake pipe.

Sufficient Time for Releasing. Sufficient time should be given for all brakes to release, and the brake valve handle should be allowed to remain in release position longer with long than with short trains. On trains of over 30 cars, the head brakes, being nearest the engine, charge more rapidly than the rear ones, due to the pressure being greater in the head end of the brake pipe than in the rear end.

During the time that the pressure is reaching the rear end of the brake pipe on long trains, and the brake valve handle is returning to running position, the brake pipe air equalizes from the head to the rear end, causing the head brakes to reapply, which makes it necessary to again place the brake valve in release position for a few seconds, after which it should be returned to running position, which will release the light application of the head brakes. A double release is thus required on long trains to insure a full release of all brakes.

Testing for Leaks. When testing for leaks in the air brake equipment, especially on the engine and tender, a brake pipe reduction of about 15 pounds should be made, the brake valve placed in lap position and the air pump shut off. If the red hand falls and the black hand remains stationary it is a main reservoir leak, but if the black hand falls and the brake does not release it is a brake pipe leak. If the black hand raises and the brake releases it indicates a leak at gasket 32, or a leaky rotary valve. If the brake releases and the black hand falls it indicates a leaky auxiliary reservoir, but if the brake releases and the black hand remains stationary it indicates a leaky graduating valve. If the brake leaks off and there is no sound at the triple exhaust there

is a leak in the pipe connection leading from the triple valve to the brake cylinder or from one driving brake cylinder to the other, a leak at the leather gasket in the brake cylinder, or a defect in the brake cylinder or head. If the engine is equipped with the high speed reducing valve, and the brake leaks off, it may be due to a defective valve, or a leak in the pipe connection leading to it.

The leaks enumerated can also be detected by making a service application of the brakes and examining all pipe connections and joints with a torch while the brakes are applied.

Observing the Air Gauge. It is of more importance to have a good light on the air than on the steam gauge, as the steam pressure is indicated by the working of the engine, while the air gauge affords the only means of ascertaining the air pressure. A clear view of the air gauge at night is very important and should be given greater attention than is usually accorded it.

An engineman should look at his air gauge frequently and should always make it a practice to notice it when approaching railroad crossings, junctions, drawbridges, stations, meeting points, before making the running test and before passing through dangerous localities.

Testing Air Gauge. The air gauge can be tested by placing the engineer's brake valve in full release position, as this places the main reservoir, brake pipe and chamber D in free communication with one another, and allows their pressures to equalize. As the black hand of the air gauge is connected with chamber D and the red hand with the main reservoir, practically the same pressure should be registered by both hands of the gauge. If there is a difference of not to exceed 3 pounds the gauge may be considered all right; if the difference is greater than this it should be reported for testing.

Number of Air Cars in Train. All working air brake cars in a train should be in service and must represent at least 75 per cent of the total number of cars in the train.

By making a five or six-pound reduction an engineman can tell approximately how many cars are coupled up by the length and strength of the brake pipe exhaust, but he cannot tell how many cars are cut in or working.

When the brake valve handle is moved from lap to release position and a blow occurs from the brake pipe exhaust it would indicate that there were only a few or no cars cut in. The short brake pipe would be charged sooner than chamber D, which would raise the equalizing piston, causing the discharge of brake pipe pressure.

Defective Triple or Obstructions in Brake Pipe. When making a service reduction an engineman can determine whether the brakes apply in emergency by a sudden momentary stoppage of brake pipe exhaust, when the brake valve handle is in service position; he also can detect a partly closed angle cock or collapsed hose, as there would be a full blow of air from the brake pipe exhaust at first, and then the blow will partly cease, due to the air passing slowly past the obstruction.

Terminal Tests—Freight Trains. Before starting on a trip the air brakes should be tested, which is a joint duty of the engineman and the trainmen. The engineman should have full excess pressure in the main reservoir when backing up to couple on the train, and while the engine is being coupled to the train he should make a reduction of about 14 pounds in brake pipe pressure, which will block an emergency application when the air is cut in.

The brakeman should open the angle cock on the tender and note whether a good blast of air is secured before making the hose coupling to the engine, and then couple up the hose and open the angle cock gradually. He should then notify the engineman that the air is cut in.

The engineman should then place the brake valve handle in full release position and allow it to remain in this position until the main reservoir and brake pipe pressures have equalized below 70 pounds, after which, with the G-6 brake valve, it should

be placed in running position. If the D-8 brake valve is used it should be left in full release until the brake pipe pressure reaches 70 pounds, while with the New York brake valve it may be placed in either full release or running position.

While the train is being charged the brakeman should pass alongside of it, inspecting the brake rigging and noting whether there are any brake pipe or auxiliary leaks; if any are found they should be remedied; if defective hose or gaskets are found they should be replaced with new ones.

When the train is charged and the engineman is satisfied that the brake system is reasonably free from leaks, the rear brakeman, stationed at the rear air car, should transmit the signal "apply air brakes" to the head brakeman, who should repeat the signal to the engineman, who will make a 25-pound brake pipe reduction, and then place the brake valve in lap position. The engineman should also note the length and strength of the brake pipe exhaust, which will indicate whether any triple applied in quick action, the length of the brake pipe and whether there is a partly closed angle cock or an obstruction in the brake pipe.

After a full reduction has been made by the engineman thus applying the brakes it is the duty of the head and rear brakemen to walk toward one another, inspecting the brake on each car to see that it applies and holds, noting the piston travel, and looking for brake pipe, cylinder and auxiliary leaks. When the brakemen meet they should signal the engineman to release the brakes, and then return to their respective ends of the train, noting that all brakes have released and that no shoes are frozen to the wheels in cold weather. If any brake fails to release it may be cut out, carded and the auxiliary reservoir drained of its air. After reaching their respective ends of the train the brakemen should notify the conductor of the condition of the train brakes and the number of cars in working order. The conductor should then in turn notify the engineman of the condition of the brakes, the number of loads and empties, their location in the train and the

amount of tonnage, so that the engineman can use his judgment accordingly when using the brakes.

Passenger Train Tests. When making a test on a passenger train at a terminal the same rule should be followed as with a freight train, but in addition the air signal line leading to the air whistle must be tested. The brakeman should pass through the train, testing the car discharge valve of each coach. He should then give the engineman the hand signal to apply the brakes from the head end of the train, and then pass alongside the train, inspecting the brakes to see that all apply. After reaching the rear of the train he should signal the engineman to release the brakes, by giving four distinct blasts of the air whistle, and then return to the head of the train, noting that all brakes release.

Running Test. When a train leaves its terminal, or a change is made in the make-up of a train, the engineman should make a running test of the brakes after the train has moved a train-length, by applying the brakes with the throttle open. As soon as the brakes are felt to take hold they should be released. This not only assures the engineman that the brakes are cut in, but also indicates how they act and hold. While this test is being made the engineman should also observe the brake pipe exhaust.

This test should be repeated when engines are changed, adding a double header, after long delays at any point on the road, when air cars are added to or set out from the train, when the engine is cut off and when the train is cut at a crossing. The head brakeman should make the terminal test on cars picked up, while the rear brakeman or the conductor should see that the brakes on the rear air cars are applied and released from the engine.

A full reduction should always be made when making a test, as a lighter one of 5 or 6 pounds would not be sufficient to force the pistons past the leakage grooves with a long train. Also with a light reduction the brakes on cars that had not been fully

charged would not apply, and it would not be possible to get full piston travel, as would be the case with a full service reduction.

If one triple valve goes to emergency position all others will follow, as a sudden reduction of brake pipe pressure rushing to the brake cylinder will cause the other triples of either type to go to emergency.

Emergency Applications Not to Be Made When Testing.

Emergency applications must not be made when testing brakes, for the reason that ordinary braking should not be done in this manner as it causes an unnecessary strain on the brake rigging, and it will be impossible to detect any defective triple valve in the train, as some brakes would set in emergency that would not set in a service application. It would also cause a waste of brake pipe air, making it difficult to release the brakes.

Detecting Defective Triples. When testing brakes with the train standing, and any brake in the train sets in quick action, it will cause a momentary stoppage of the brake pipe exhaust, as the brake pipe pressure would be vented to the brake cylinder of each car, reducing the pressure below that in chamber D, which in turn would seat the equalizing piston.

Locating Defective Triples. To locate a defective quick action triple on a train of from 5 to 10 cars the engineman should make a 5-pound brake pipe reduction, and the car on which the brake does not set should be located. When the car is located a further reduction should be made and if the brake on this particular car sets quick action it should be cut out and carded. The entire train should then be recharged and another test made, to ascertain that the defective triple has been found. On a long train it would be necessary to make a sectional test in order to locate the car with the defective triple, cutting in 10 cars with each test and proceeding as above described.

Inspect All Brakes. When making a thorough test it is necessary to hold the brakes set until the trainmen have sufficient time to inspect all the brakes thoroughly. The longer a brake remains applied the more certain an engineman can be that it

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will hold for a long, hard stop. A brake that will not remain applied for a minute or longer is considered a poor brake and should be carded.

Releasing Before Uncoupling. The air brakes should be released before uncoupling, which prevents the brake shoes from freezing to the wheels and the triples from freezing in set position in cold weather. If the brakes were left applied when cutting off to take water and coal there would be an additional reduction from the brake pipe by leakage, and it would require a larger volume of air to release the brakes when the engine was recoupled; also if the brakes released on a grade, the slack would run in, which might start the train. The air brakes should not be relied upon for holding a train on grades when the engine is cut off.

Loss of Excess Pressure. If the handle of the D-8 brake valve is left in full release position too long and then brought back to running position the excess pressure would be lost, and if there were any leaks in the brake pipe they would cause the brakes to apply before sufficient excess pressure was accumulated in the main reservoir to unseat the excess pressure valve and supply the brake pipe.

If the brakes apply with the handle of the D-8 brake valve in running position after a release of the brakes has been made it would be due to a lack of excess pressure, as with this type of valve in running position it is necessary to obtain excess pressure in the main reservoir before air can pass into the brake pipe. If care is taken to prevent the loss of excess pressure when making the release this trouble will not be experienced.

Overcharging. If the G-6 brake valve were left in release position too long the excess pressure in the main reservoir would be lost and the brake pipe and auxiliary reservoirs overcharged, and when the brake valve was placed in running position there would have to be a leak in the brake pipe or the pressure in the brake pipe reduced below that for which the feed valve was set before any air could pass from the main reservoir to the brake

pipe, which would cause the brakes to apply. This difficulty would not be experienced with the B2 and the B3 New York brake valves, as the controllers prevent the brake pipe from becoming overcharged in all positions of the brake valve.

With the D-8 brake valve the brake pipe pressure is regulated by the pump governor, and in lap position communication between the main reservoir and the brake pipe is closed and the governor does not control the pump. Consequently when the brake valve is left in lap position too long the pump will operate until the main reservoir pressure is equal to the steam pressure of the boiler. When the brake valve is placed in release position this high excess pressure is liable to result in bursting of an air hose, overcharging the brake pipe and auxiliary reservoirs, and stopping the pump, which will not go to work until the brake pipe pressure is reduced, or has leaked down below the pressure at which the governor is set, causing the brakes to apply.

Speed of Pump Descending Grades. With the D-8 brake valve the pump should not be run at a high rate of speed while descending heavy grades, but the speed of all pumps should be sufficient to maintain the proper excess pressure in the main reservoir required to insure a prompt release of brakes and a rapid recharge of brake pipe and auxiliary reservoir pressures.

Failure of Brakes to Release and Causes for Brakes Dragging. When the brakes drag or fail to release it is usually due to lack of sufficient excess pressure, especially on long trains, failing to make a second release on long trains, failure to leave the brake valve handle in release position a sufficient length of time, or making light reductions and releasing. The last is one of the most frequent causes of brakes sticking.

Another cause is the overcharging of the brake pipe, which usually results from leaving the brake valve handle in release position too long when releasing, thus allowing both the brake pipe and auxiliary reservoirs to become overcharged. In this event the leakage from the brake pipe is not supplied, as with the D-8 and the New York brake valves the excess pressure valve closes until

excess pressure has again accumulated in the main reservoir. With the F-6 and G-6 brake valves, if the brake pipe pressure is raised above 70 pounds, the feed valve closes and leakage will reduce the pressure in the brake pipe until it falls below 70 pounds. Until the pressure is reduced to this point the brakes will drag.

Another frequent cause of brakes dragging results from enginemen moving the brake valve handle from running to release position in trying to release imaginary brake dragging. If this is done too often the brake pipe and auxiliary reservoirs will become overcharged and the brake dragging will become actual instead of imaginary.

A heavy leakage from the brake pipe will also cause brakes to drag. This leakage usually occurs when trains are stretched after standing, particularly in cold weather when the air hose becomes frozen.

Leaks that result in applying the brakes may arise from a defective governor with a D-8 brake valve, or defective feed valves with the G-6 brake valve, where either of these interfere with the supply of air to the brake pipe. The failure of the governor to act, thus holding the pump idle, or the feed valve shutting off the supply of air from the brake pipe, will give the leakage a chance to apply the brakes.

How to Release Brakes That Are Sticking. When brakes are dragging they can be successfully released by using one of the following methods: If the brake pipe pressure is below normal (as it will be if leakage applies the brakes), and the proper excess pressure is maintained in the main reservoir and if there is sufficient room in the brake pipe for the excess pressure without overcharging, the brake valve handle should be placed in full release position, as in making the ordinary release. But if the brake pipe pressure is normal and the brakes are applied (which may occur with an improper release), the brake valve should be placed in lap position and left there until full excess pressure is obtained, when a 10-pound reduction should be made and the brakes released. If the brake pipe pressure is below normal, and there is

no excess pressure in the main reservoir, the brake valve should be placed in lap position until the necessary excess pressure is accumulated, when the brakes should be released.

An engineman should never attempt to pump the brakes off or try to release them when the brake pipe pressure is up to standard, as it will result in the brake pipe and auxiliary reservoirs becoming overcharged, and will cause all brakes to apply.

Two-Mile Test. The two-mile running test should be made before descending heavy grades and when approaching terminals, meeting points, railroad crossings, junction points, interlocking plants, ends of double tracks and other dangerous places where a stop may be required. This test is made by making a sufficient reduction of brake pipe pressure on freight trains to raise the equalizing piston with a 3 or 4-pound reduction, and noting the length and strength of the brake pipe exhaust. On passenger trains a 10-pound reduction should be made and the engineman should feel the brakes take hold, in addition to noting the length and strength of the brake pipe exhaust, and then release the brakes.

Automatic Application. If the brake suddenly applies without a reduction being made by the engineman the engine should be shut off and the handle of the brake valve placed in lap position at once. The application of the brakes may result from a bursted hose, the train parting, or the conductor's valve being opened. Care should be exercised to keep the detached parts of the train together to prevent as much damage as possible and to maintain the main reservoir pressure so that it will be available for releasing the brakes when necessary.

When a train breaks in two and the sections come to a stop, or in the case of a bursted hose, the brake valve should be placed in running position in order to ascertain whether the brake pipe is still open, which would be indicated by the air gauge. The brake valve should be kept moving from running to lap position until the defective hose or leak is located. By handling the brake valve in this manner the defect can easily be located by the

trainmen from the intermittent sound of the escaping air. If the black hand of the air gauge raises when the brake valve is in running position it indicates that the defect has been located and the angle cock closed just ahead of it. The brakes should then be released, the brake valve placed in lap position and excess pressure obtained in the main reservoir, so that the brakes on the rear cars may be released when the defective hose has been replaced or the train has been recoupled.

If, after coupling up, it is impossible to release all the brakes, the brake valve should be placed in full release position, allowing the pump to force air directly into the brake pipe. When the pressure in the brake pipe reaches 58 or 60 pounds the brake valve should be placed in lap position and left until the full amount of excess pressure has accumulated in the main reservoir, when the brakes can be released in the usual manner.

Use of Tail Hose. When backing up a train with the tail hose in use the brake pipe should first be blown out before attaching the tail hose, the terminal or road test of the air brakes should be made by the engineman and a test of the tail hose should then be made by the trainmen stationed on the rear car. The latter test should be made after the train is in motion, the first application being made about 200 feet or three car-lengths from the starting point. If a slow-down is not felt within this distance the engineman should bring the train to a stop and ascertain why the test has not been made. The engineer's brake valve should be carried in running position, and not placed in lap position, to assist in making an application from the tail hose. Following either a slow-down or a stop, when a signal to continue backing is given, the brake valve should be moved to release position, as in making a regular brake release, to insure a release of all brakes. The engineman should apply the automatic brakes whenever it is required to insure the safety of the train, in the absence of a sufficient application from the tail hose.

Trainmen should understand that in operating the brakes with the tail hose, and when the brake valve is in running posi-

tion, the valve of the tail hose should be opened slowly and the opening gradually increased until the valve is wide open, or the train has slowed down as much as desired or has been brought to a stop. This valve should not be opened and closed. If the application has been too hard the closing of the tail hose valve will allow the brakes to release and recharge. The rapidity with which the valve is opened should be determined by the speed, the length of the train and the distance within which it must be stopped. In cases of emergency the valve should be instantly opened to its full extent. On grades where a train will not stand with brakes released it should be held by admitting a little steam to the cylinders with the engine reversed.

Two or More Engines Coupled. When two or more engines are coupled together the engineman on the leading engine should do the braking, as his view is not obstructed, and he is able to use better judgment in handling the brakes.

Switching. In doing switching with an air brake train, the braking should be done in service with the automatic brake valve, provided the air brake cars are coupled up and cut in. If they are not coupled up and cut in the independent or straight air brake valve should be used. When air cars are picked up and added to the train, or when the engine is coupled to cars that are to be moved quickly, it is a good plan to apply and release the brakes on the engine several times while backing up the cars. The brake valve should then be placed in lap position until a high excess pressure is accumulated in the main reservoir, the cars coupled to and the angle cocks turned so that the cars are cut in. This reduces the pressure in the auxiliary reservoirs of the engine and tender and whatever cars are coupled to the engine, so that when the additional air brake cars are coupled to it will take but a short time for all brakes to be released, allowing the train to proceed. Otherwise the amount of air required to charge the added cars would be so great that the brakes on the engine, tender and attached cars would remain applied, and it

would be impossible to proceed until the brake pipe pressure could be raised above the equalized pressure.

The purpose of making these reductions and accumulating excess pressure in the main reservoir is to enable the engineman to move the cars and charge them while moving before they are coupled to the train.

Before the brakes on the balance of the train are cut in the engineman should reduce the pressure sufficiently to block quick action. After the signal is given that all cars are cut in, a prompt release of all brakes should be made, and when the brake pipe and auxiliary reservoirs are again charged, the usual terminal test should be made on the cars picked up. It should also be noted whether the brakes on the rear air car applied and released properly.

Reducing Speed When Approaching Descending Grades. When approaching long, descending grades the speed of the train should be checked, full pressure accumulated and the brakes applied in time. An engineman should not wait until a full application is necessary to check the train, as the speed may not be reduced sufficiently by the time the brakes require recharging. A moderate application should be made in time, and the trainmen should see that the required number of retaining valves are closed whenever the retainers are to be used.

Recharging When Descending Grades. An engineman should always plan to recharge the brakes on a let-up, where grades are not steep, or while passing around curves, as by so doing the train will not gain a speed beyond control during the time the brakes are being recharged.

When recharging, the brake valve should be placed in full release position and allowed to remain there until both hands of the air gauge are just past the 70-pound mark. With the retaining valves in use the engineman should remember that a light reduction will be much more effective than if the retainers were not in use. For example, if a 5-pound reduction is made with the retainers not in use a pressure of about 12 pounds is obtained

in the brake cylinders, while with the retainers closed a pressure of about 15 pounds is obtained when making two or more applications, the extra braking power being due to the pressure retained in the brake cylinder by the retaining valves.

Minimum Reductions. A reduction of not less than 5 or 6 pounds should always be made, even when the retaining valves are in use, as some of them may be out of order and fail to retain any pressure in the brake cylinder and, unless a sufficiently heavy reduction to carry the pistons past the leakage grooves is made, no braking power will be obtained from the cars having defective retainers.

Loss of Braking Power. An engineman should not place too much reliance on his brakes and should watch the air gauge closely. A small leak from the brake pipe, after making the first reduction, will allow just enough air to leak away to make a smooth stop. But if the brake pipe air has gradually leaked away (from any cause) without a reduction having been made by the engineman, it is difficult to gain control of the train, and it cannot be stopped by air until the brakes have been recharged. This would require considerable time and probably by the time the brake pipe and auxiliary reservoirs were recharged control of the train would be lost.

Alternating Engine and Train Brakes. If the engine is equipped with the combined automatic and straight air brakes, the ET equipment, the New York air brakes, or other devices to maintain the driver brake pressure, the straight air feed can be used to assist in holding the train while recharging the automatic brakes. Engines equipped with the combined automatic and straight air brakes are also equipped with grade bleed cocks, which should be open on grade work, thus allowing the automatic pressure of the driver and tender brakes to escape. While recharging the brake pipe and auxiliary reservoirs the independent or straight air brakes should be applied. The alternate use of the automatic brakes, the straight air and retaining valves is for the

purpose of preventing tires from becoming loose or wheels overheated.

Use of Hand Brakes. Hand brakes should be used on non-air cars of a train only upon a signal for brakes, and when a train consisting of part air cars is backing the hand brakes should always be used to furnish most of the braking power required. When the engineman requires additional braking power on account of lack of sufficient air brake cars the hand brakes immediately behind the air cars should be used when going ahead. The hand brakes should also be used when a car is set on a siding and when a train is left standing on a grade, or any other place where there is a possibility of cars starting.

Part Air Brake Freight Trains. To ordinarily apply and release the brakes on a freight train consisting of part air brake cars the engineman should shut off the engine throttle and allow the engine to bunch the slack of the train. He should then make a sufficient reduction to move the pistons past the leakage grooves and further allow the slack to bunch. He should then make sufficient reductions to bring the train to a stop, and release the brakes just as the train stops, in order that the brakes on the air cars may be entirely released before the slack of the non-air cars can run out, thus avoiding a parting of the train. If the engine is equipped with the ET equipment, combined automatic and straight air brake, or the New York B2 or B3 equipment, the straight air brake can be applied, the automatic brakes released and the driver and tender brakes graduated off without causing any shock to the train.

All Air Brake Freight Trains. To apply and release the brakes on a full air brake freight train the engineman should shut off the throttle and make sufficient reductions of from 5 to 10 pounds, according to the length of the train. Care should be taken not to make the reductions too heavy, or serious damage may result from the rapid bunching of the train. It should be remembered that the reduction necessary to force the pistons past the leakage grooves varies according to the length of the train.

With a train consisting of 20 cars, or less, a 5-pound reduction will be sufficient. One pound should be added to this amount for each additional 10 cars added to the train. Any further reductions should vary in amount according to the length of the train, in the same proportion as the first reduction, and the intervals between reductions are also dependent on the length of the train.

If one reduction is followed by another before the brake pipe exhaust ceases the two reductions will act as one. The longer the train, the longer the brake pipe exhaust will blow; consequently, a longer interval must be allowed between reductions on long trains than with short ones. When the speed of long freight trains is reduced to 10 or 15 miles per hour, and the engineman desires to release the brakes before stopping, unless the speed of the train or the lay of the track is such that there is no danger of parting the train, it would be better policy to come to a full stop before releasing. If, however, the engine were equipped with the combined straight air and automatic brakes, ET equipment, or New York brake, the engine and tender brakes can be applied and the automatic brakes released without danger of parting the train, even at the slowest speeds.

Empty Cars Ahead and Loads on the Rear of Train.

If a train consists of empty cars ahead and loads behind, the engineman should shut off the engine throttle, allowing the engine to bunch the slack, and then make a sufficient reduction, according to the length of the train, to force the pistons past the leakage grooves. When the brake pipe exhaust has ceased and the slack is bunched, another reduction should be made to bring the train to a stop. Full excess pressure should be accumulated in the main reservoir before releasing the brakes.

Loads Ahead and Empties on the Rear. If an air brake train consists of loads ahead and empties behind a sufficient reduction should be made to force the pistons past the leakage grooves before shutting off the engine, thus keeping the train

stretched. A sufficient reduction to bring the train to a stop should then be made, and the brakes released.

Reversing Engine. While the driver brakes are applied the engine should never be reversed with the expectation of making a shorter stop than can be made with the brakes alone. For if this is done the driving wheels are almost sure to lock, and then almost the entire retarding power of the engine has been lost, as the steam cylinders are acting as air compressors, and this force exerted on the drivers with the air brakes applied would cause them to lock and slide. In close quarters there is a tendency among enginemen to reverse the engine in addition to applying the brakes. If this action has not been the direct cause of many wrecks it certainly has not prevented any, unless the driver brakes had lost their braking power through leakage immediately after the application was made. The only time when reversing is of advantage is when the engine is equipped with a poor driver brake or none at all.

Drivers Sliding. If in making a stop with a heavy freight train the drivers begin to slide, and it is not advisable to release the brakes for fear of breaking in two, the reverse lever should be placed in full gear in the direction in which the engine is moving, and the throttle opened. This will usually start the drivers, but if it fails to do so the brake valve should be placed in release position, as it is better to take chances of pulling out a drawbar rather than flattening the driver tires.

If the drivers slide on an engine equipped with the combined automatic and straight air brakes the grade bleed cock should be opened, which will release the driver brakes; if with the ET equipment, the independent brake valve should be placed in release position, and if the New York air brake is used, the lever safety valve should be opened.

Use of Sand. Sand on the rail is used for two purposes; to cause the wheels to grip the rail and to increase the friction between the brake shoe and the wheel, thus lessening the danger of wheels being flattened by sliding and also making a shorter stop.

To use sand properly requires good judgment. When it is desired to make a quick stop, a stop on a descending grade, or a stop on a slippery rail, and a heavy application is intended, the air sander should be opened and the rail under the entire train sanded before a reduction in brake pipe pressure is made. The sand should then be used lightly and continuously until the train is brought to a stop. Sand should not be used after the wheels begin to slide, as they will not start revolving again, and the resulting flat spots on the wheels will be worn larger. It is bad practice when stopping a train to use the sand after an application has been made, as some of the wheels may be sliding, and flat spots will be the result. This applies to freight as well as passenger trains.

Number of Applications. An engineman should plan to make all ordinary stops of passenger trains with two applications of the brakes. This is practiced on the majority of roads and by the exercise of good judgment and care, accurate and smooth stops can be made. The first application should be sufficient to reduce the speed to 15 or 18 miles per hour. The brakes should then be released by placing the brake valve in full release position, and the brakes recharged if the time is sufficient; if not, the brake valve should be placed in lap position and a second light application made to stop the train at the desired point. If the speed of the train is low, one application will be sufficient, as one or two light reductions with low cylinder pressure will make the stop nicely.

The brake valve is placed in lap position after the first application in order to prevent surplus air from entering the brake pipe. The air admitted should be just sufficient to raise the brake pipe pressure enough to release the brakes without recharging the auxiliary reservoirs. The feed grooves in the triple valves are comparatively small, and when the brake pipe is charged higher than the auxiliaries, unless there is sufficient time for the two pressures to equalize before making the second application, the excessive brake pipe pressure must be reduced an additional

amount before the second application can be made effective. This requires considerable time, as well as distance, and a heavy reduction would be necessary to make the second application, which would probably result in an inaccurate and disagreeable stop.

In making a stop with a passenger train on a slippery rail the engineman should shut off the engine at a reasonable distance for making the stop, and apply sand to the rail for the full length of the train before applying the brakes. A sufficient reduction should then be made to bring the speed of the train down to 15 or 18 miles per hour, and the brake valve moved to release position and left there ordinarily one-half second for each car in the train, in order to insure a release of all brakes. The brake valve should then be placed in lap position, so that the final stop may be made with a light application and low brake cylinder pressure, the sander being allowed to run until the train is fully stopped. If the conditions are such that the sanders cannot be depended upon, as with a side wind or the sanders stopped up, the braking should be done as described, but it would be necessary to make a heavy application at high speed. If a spot stop is necessary a third application is advisable.

On a passenger train running at high speed a moderate reduction of at least 10 pounds should be made to prevent the train from lurching as the engine and cars strike a curve. The application should be made an engine-length before reaching the curve, and the brakes allowed to remain applied until the last car is well on the curve, when the release can be made, as the lurch is over as soon as the flanges of the wheels crowd the outer rail. On short curves the brakes should be held on until the train is entirely off the curve.

Approaching Dangerous Localities. When approaching dangerous points where switch engines are employed, interlocking plants, railroad crossings, drawbridges, meeting points and yards, the brake pipe and auxiliary reservoirs should be fully charged between the first and second applications, so that in case

of an emergency there would be ample braking power available.

Final Stops—Passenger Trains. When making a stop with a passenger train of less than 10 cars the brakes should be released just before the train stops, as the brakes of passenger cars are usually hung from the trucks, and when the brakes are applied the trucks tilt. If they are held on until the stop is made the movement of the trucks when leveling themselves causes a backward lurch of the train that is very disagreeable to passengers. This lurch is avoided by releasing and allowing the trucks to adjust themselves just before the stop is completed. The time at which the final release should be made depends on the amount of the brake application, as the harder they are applied the longer it will take to release them. When a train consists of 10 cars or over the brakes should be held on with the second application until the train is brought to a full stop, unless the engine is equipped with a retainer, straight air brake, ET equipment, or the New York improved brake equipment.

Service Applications With High Speed Pressure. With full high speed brake pipe pressure, three full service applications may be made without recharging the auxiliary reservoir, and there would still remain as much pressure in the auxiliary as is used with the ordinary brake.

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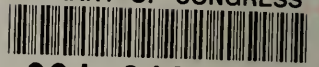
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